



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



E.D.
U58.3b
v. 1-7 2nd edit.

237.1

Library of the Museum
OF
COMPARATIVE ZOÖLOGY,
AT HARVARD COLLEGE, CAMBRIDGE, MASS.

The gift of
The U. S. Entomolo-
gical Commission
No. 6804.

May 21. 1877 - Apr. 5. 1882.

DEPARTMENT OF THE INTERIOR.
U. S. GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.
F. V. HAYDEN, IN CHARGE.

BULLETIN
OF
THE UNITED STATES
ENTOMOLOGICAL COMMISSION.

DESTRUCTION OF THE YOUNG OR UNFLEDGED LOCUSTS.

No. 1.

SECOND EDITION.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
June, 1877.

PREFACE.

The publications of the Commission will consist of circulars, bulletins, memoirs, and the annual report of doings and results of the work of the Commission. The bulletins will contain such special information as may be of interest and importance at the time of publication. They will be issued partly in anticipation of the annual report, and principally to meet the demand for information and the numerous inquiries made of the Commission at the time. The present number has exclusive reference to the destruction of the young insects which will so largely occupy the attention of our western farmers for the next two months. It will be at once followed by a second number on the natural history and habits of the species.

C. V. RILEY,
A. S. PACKARD, JR.,
CYRUS THOMAS,
Commissioners.

SAINT LOUIS, MO., *April 2, 1877.*

DESTRUCTION OF THE YOUNG OR UNFLEDGED LOCUSTS.

ARTIFICIAL MEANS.

This bulletin may reach many farmers in the Northwest before the locust-eggs have all hatched. The only feasible way of now destroying these is to plow them deeply under where that is possible. The plowing will be effectual according as the soil is porous or tenacious, *and according as the surface is afterward compressed by harrowing and rolling.* All other things being equal, a plowing of 4 to 6 inches will prove more effectual, if the ground be subsequently harrowed and rolled, than deeper plowing with no subsequent comminution and compression. We advise the farmers in the locust region to supply themselves with early-ripening seed-corn, and to prepare to grow more leguminous and tuberous crops than is the custom. But as the principal struggle during the next two months will be with the young insects, we devote this bulletin more particularly to the best means of overcoming them.

Heavy rolling, where the surface of the soil is sufficiently firm and even, destroys a large number of these newly-hatched young, but is most advantageously employed when they are most sluggish and inclined to huddle together, as during the first eight or ten days after hatching, and in the mornings and evenings subsequently. They then drive almost as readily as sheep, and may be burned in large quantities by being driven into windrows or piles of burning hay or straw. They may also be killed with kerosene, and by means of flattened beating implements; wooden shovels being extensively used for this purpose in Europe.

But to protect the crops and do battle to these young locust armies, especially where, as was the case in much of the ravaged country in 1875, there is little or no hay or straw to burn, the best method is ditching. A ditch 2 feet wide and 2 feet deep, with perpendicular sides, offers an effectual barrier to the young insects. They tumble into it and accumulate, and die at the bottom in large quantities. In a few days the stench becomes great, and necessitates the covering up of the mass. In order to keep the main ditch open, therefore, it is best to dig pits or deeper side ditches at short intervals, into which the 'hoppers will accumulate and may be buried. Made around a field about hatching-time, few 'hoppers will get into that field till they acquire wings, and by that time the principal danger is over, and the insects are fast disappearing. If any should hatch within the inclosure, they are easily driven into the ditches dug in different parts of the field. The direction of the apprehended approach of the insects being known from their hatching locality, ditching one or two sides next to such locality is generally sufficient, and when farmers join they can construct a long ditch which will protect many farms.

We have not a doubt but that with proper and systematic ditching early in the season, when the insects first hatch, nearly everything can be saved. Where water can be let into the ditches so as to cover the bottom, they may be made shallower, and still be effective.

A ditch 3 feet wide, unless correspondingly deep, will be more apt to permit the escape of the insects when once in than a narrower one. In hopping, the more perpendicular the direction the insects must take the shorter will be the distance reached. Of course, the wider the ditch, if it be correspondingly deep, the more effectual will it prove. In exceptional cases, when the locusts are nearly full grown and the wind is high, so as to assist them, even the two-foot ditch loses much of its value.

Next to ditching, the use of nets or seines, or converging strips of calico or any other material, made after the plan of a quail-net, has proved most satisfactory. By digging a pit, or boring a post-auger hole 3 or 4 feet deep, and then staking the two wings so that they converge toward it, large numbers of the locusts may be driven into the pit after the dew is off the ground. By changing the position of this trap, much good can be done when the insects are yet small and huddled in schools. But all modes of bagging, netting, crushing with the spade or other flat implements, and burning, which can be employed to good advantage when the insects first begin to hatch, become comparatively useless when they begin to travel in concert over wide stretches of land. The same may be said of all the mechanical contrivances to facilitate the destruction of the insects; they are useful if used in concert in a given neighborhood soon after the young hatch, but subsequently do not compare to ditching. There are a number of contrivances that have been more or less successfully used, but we cannot treat of all of them in detail. We shall, rather, at this time, content ourselves with descriptions of a few, which will illustrate the principle to be kept in view.

Those used in Minnesota, so far as we can learn, are applications of one principle, viz, an open-mouthed bag, dragged by hand or horse power. We have seen a very large one that would take from eight to twelve bushels of pupæ per day; but this was after the insects had been pretty effectually fought by burning and otherwise. It was very effective. Its owner proposes to place his whole dependence on it next year. It had one addition over others that we think valuable. It ran back 10 feet or more to a bag, and near the rear end two or three square feet of cloth had been cut out and replaced by wire gauze. This gave a chance for the air to draw through, and as locusts worked toward the rear end they made way toward the light shining through the wire. This machine was rigged on cart-wheels, and the only expense was in getting three long poles from the woods, and in purchasing about forty yards of cotton muslin.

Maj. J. G. Thompson, of Garden City, Minn., has used with satisfaction a net made as follows:

Two pieces of common batten about 16 feet long were used as frame-work for the mouth of the net, one for the bottom and one for the top. From the end of the bottom piece a wooden shoe of the same material ran back about 6 feet to steady the trap and serve as a runner. To the rear end of this shoe a similar piece was fastened by a hinge, and ran forward and was fastened to the top piece of the frame, so that the mouth of the trap would open and shut like a jaw. To hold the mouth open, two short upright posts were fastened to the top piece by a hinge, and rested upright upon the bed-piece. The net itself was made of cotton cloth for the bottom, and the top was made of mosquito-netting. The mouth of the net extended 16 feet from one side of the trap to the other, and the net ran back about 6 feet to a point with a hole at the end to let out the insects collected. A boy ten years old can draw one end of this net, and by the use of it Major Thompson saved one piece of wheat.

Similar machines have been drawn by horses hitched to each side of the trap, being 12 to 16 feet apart. The horses serve the purpose of driving the locusts inward toward the mouth of the net. There have

been many forms of these machines, but all on the same general principle.

In Colorado, also, machines have been used to good advantage, most of them having for their object the burning of the young insects. Mr. J. Hetzel, of Longmont, uses a burner drawn by horses. It is 12 feet long, 2 to 2½ feet wide, and made of iron, set on runners 4 inches high. An open grate on the top of the runners is filled with pitch-pine wood, and a sheet covers the grate to keep the heat down. The grate is generally made with a net-work of heavy wire, such as telegraph-wire. Two men and a team will burn 10 to 12 acres a day, and kill two-thirds of the insects, but it requires a hot fire. Mr. C. C. Horner gives in the *Colorado Farmer* the following more detailed description of a machine which works on the same principle:

It consists of three runners made of 2 × 4 scantling 3 feet in length, to be placed 6 feet apart, making the machine 12 feet wide, runners to be bound together by three flat straps or bars of iron (the base being 12 feet long). Across the top, bars of iron hold the runners firmly together and form a frame across which wire can be worked, to make a grate to hold fire. The upper part of the runners should be hollowed out so that the grate may slide along within 2 inches of the ground. A sheet-iron arch should be set over this grate to drive the heat downward. This machine is very light, and can be worked with one horse. Pitch-wood is best adapted to burning, and can be chipped the right length and size and left in piles where most convenient when needed. This machine is intended to be used when the little 'hoppers just make their appearance along the edge of the grain, going over the ground once or twice each day, or as often as necessary to keep them killed off. The scorching does not kill the grain, but makes it a few days later. This is certainly the cheapest manner of getting rid of this pest, as well as the most effectual.

Mr. Rufus Clark, of Denver, according to the same paper, uses a piece of oil-cloth 9 to 12 feet long and 6 feet wide. One side and each end are secured to light wooden strips by common carpet-tacks, and the corners strengthened by braces. The oil-cloth is smeared with coal-tar, purchased at the Denver gas-works for \$.75 per barrel, and the trap is dragged over the ground by two men, a cord about 10 feet long being fastened to the front corners for that purpose. The entire expense of the "trap" is about \$3.50, and as it is light and easily handled, will be found serviceable on small as well as large farms. Zinc, instead of oil-cloth, has also been used for the same purpose.

When the insects are famishing, it is useless to try and protect plants by any application whatever, though spraying them with a mixture of kerosene and warm water is the best protection we have tried, and will measurably answer when the insects are not too numerous or ravenous.

The best means of protecting fruit and shade trees deserves separate consideration. Where the trunks are smooth and perpendicular they may be protected by whitewashing. The lime crumbles under the feet of the insects as they attempt to climb, and prevents their getting up. By their persistent efforts, however, they gradually wear off the lime and reach a higher point each day, so that the whitewashing must be often repeated. Trees with short, rough trunks, or which lean, are not very well protected in this way. A strip of smooth, bright tin answers even better for the same purpose. A strip 3 or 4 inches wide brought around and tacked to a smooth tree will protect it, while on rougher trees a piece of old rope may first be tacked around the tree and the tin tacked to it, so as to leave a portion both above and below. Passages between the tin and rope or the rope and tree can then be blocked by filling the upper area between tin and tree with earth. The tin must be high enough from the ground to prevent the 'hoppers from jumping from the latter beyond it, and the trunk below the tin, where the insects collect, should be covered with some coal-tar or poisonous substances to prevent

girdling. This is more especially necessary with small trees, and coal-tar or whitewash having Paris green mixed with it will answer as such preventives.

One of the cheapest and simplest modes is to encircle the tree with cotton batting, in which the insects will entangle their feet, and thus be more or less obstructed. Strips of paper covered with tar, stiff paper tied on so as to slope roof-fashion, strips of glazed wall-paper, and thick coatings of soft soap, have been used with varying success; but no estoppel equals the bright tin. The others require constant watching and renewal, and in all cases coming under our observation some insects would get into the trees, so as to require the daily shaking of these morning and evening. This will sometimes have to be done, when the bulk of the insects have become fledged, even where tin is used, for a certain proportion of the insects will then fly into the trees. They do most damage during the night, and care should be had that the trees be unloaded of their voracious freight just before dark.

Most cultivated plants may be measurably protected from the ravages of these young by good cultivation and a constant stirring of the soil. The young have an antipathy to a loose and friable surface, which incommodes them and hinders their progress, and they will often leave such a surface for one more hard and firm.

Finally, though insisting on ditching and the digging of pits as, all things considered, the best and most reliable insurance against the ravages of the young locusts, we would urge our farmers to rely not on these means alone, but to employ all the other means recommended, according as convenience and opportunity suggest.

Another method of destroying the young has been proposed and to a certain extent adopted. It promises, if carried out effectually, to be of much advantage. It is to protect the prairie-grass from fires until spring, and, after the bulk of the eggs are hatched, to simultaneously burn over the entire neighborhood, township, or county, or as far as the combination may extend. This requires concerted action and considerable watchfulness, but if carried out rigidly will destroy a very large number of insects, and has the advantage of being inexpensive. It is inapplicable on the cultivated grounds, but applies to the areas where the other measures are least effective.

NATURAL MEANS.

One of the most effectual means of destroying the young locusts, and one which is too often overlooked because its effects are not so directly apparent, is the preservation and multiplication of the native birds. Without undertaking at this time to specify the species which should be especially protected, and about which there is yet some difference of opinion, we feel warranted in stating that until the useless species in this respect are distinguished from those that are beneficial, it is best to protect all insect-eating birds, and if the laws of the State are insufficient for this purpose, let communities, townships, and counties use all their lawful powers therefor.

Chickens, turkeys, and hogs devour locusts in immense quantities, and thrive during years of locust invasion or whenever these insects abound. Prairie-chickens and quails devour them with avidity, and even hunt for their eggs; swallows and blackbirds pursue them unrelentingly; the little snow-birds devour great quantities of eggs when these are brought to the surface by the freezing and thawing of the ground, and the same may be said of almost all birds inhabiting the western country in winter.

The good offices of birds were everywhere noticed in 1875. Prof. F. H. Snow, of Lawrence, Kans., found the young locusts in the gizzards

of the Red-headed Woodpecker (*Melanerpes erythrocephalus*), Yellow-billed Cuckoo (*Coccyzus americanus*), Cat-bird (*Mimus carolinensis*), Red-eyed Vireo (*Vireo olivaceus*), Great-crested Fly-catcher (*Myiarchus crinitus*), and Crow Blackbird (*Quiscalus versicolor*), species that had not been noticed to feed on them before. The shrike or butcher-bird impales them onto thorns and other pointed substances; and a number of other birds, as well as reptiles, *e. g.*, toads, frogs, and snakes, feed upon them.

We therefore strongly recommend the raising of as large a number as possible of hogs and poultry both as a means of utilizing and of destroying the young locusts.

LEGISLATION.

For the purpose of encouraging the farmers in the work of destroying these pests, three of the States interested, viz, Missouri, Kansas, and Minnesota, have passed laws granting bounties or authorizing combined action. We herewith quote said laws for the benefit of those in these States into whose hands this bulletin may fall.

MISSOURI.

AN ACT to encourage the destruction of grasshoppers.

Be it enacted by the general assembly of the State of Missouri as follows :

SECTION 1. Any person who shall gather, or cause to be gathered by any person in his employ, eggs of the Rocky Mountain locust or grasshopper, at any time after they are deposited in the earth in the autumn of any year, and before they are hatched the following spring, shall be entitled to a bounty of five dollars for each and every bushel of eggs thus gathered, or for any quantity less than one bushel, bounty at the same rate, to be paid, one-half by the State and one-half by the county in which they are gathered.

SEC. 2. Any person who shall gather, collect, and kill, or cause to be so collected and killed, young and unfledged grasshoppers in the month of March, shall be entitled to a bounty of one dollar for each bushel, and for the month of April, fifty cents per bushel, and for the month of May, twenty-five cents per bushel, to be paid in the same manner as in the preceding section.

SEC. 3. Any person claiming bounty under this act shall produce the eggs and grasshoppers thus gathered or killed, as the case may be, before the clerk of the county court in which such eggs or grasshoppers were gathered or killed within ten days thereafter, whereupon said clerk shall administer to such person the following oath or affirmation: You do solemnly swear (or affirm, as the case may be) that the eggs (or grasshoppers, as the case may be) produced by you, were taken and gathered by you, or by person or persons in your employ, or under your control, and within this county and State.

SEC. 4. The clerk shall forthwith destroy said eggs by burning the same and give to the person proving up the same, under his hand and seal, a certificate setting forth in a plain handwriting, without interlineation, the amount of eggs or grasshoppers produced and destroyed by him, and the name and residence of such person producing the same, which certificate shall be in the following form:

"STATE OF MISSOURI, County of _____:

"This is to certify that _____, in the county of _____, A. B., did this day prove before me that he had gathered, or caused to be gathered _____ of eggs, _____ grasshoppers, and is entitled to the sum of _____ dollars and _____ cents.

"Given under my hand and seal of my office this _____ day of _____, A. D. 18—
"_____, A. B., Clerk County Court."

Which certificate shall be received and taken by the collector of revenue of the county in which the same was given, and such collector shall be allowed pay out of the county and State treasury, one-half from each.

SEC. 5. Such clerk shall keep a register of all such certificates given by him, in a book which he shall keep for that purpose, in which he shall note down every certificate granted by him, the number and amount, and to whom granted, and transmit a certified copy of such register, under the seal of the court, to the treasurer of the State, who shall not allow and pay any certificate which does not correspond with such register.

SEC. 6. Such clerk shall receive for his services as aforesaid one dollar for such certified copy of the register, and the regular fee for the certificate and seal, and ten cents

for each certificate granted under this act, all to be paid out of the treasury of his county.

SEC. 7. As the object of this act is the rapid destruction of the locust the ensuing spring, it shall take effect and be in force from and after its passage.

Approved February 23, 1877.

KANSAS.

AN ACT to provide for the destruction of grasshoppers and to punish for violation of this act.

Be it enacted by the Legislature of the State of Kansas :

SECTION 1. That the township trustees of the different townships, and the mayors of cities which are not included in any township of any county within this State, are hereby authorized and it is made their duty, when so requested, in writing, by fifteen of the legal voters of the township or city, to issue orders to the road-overseers of the different road-districts within their respective townships or cities, to warn out all able-bodied males between the ages of twelve and fifty years, within their respective districts, for the purpose of destroying locusts or migratory insects.

SEC. 2. It shall be the duty of road-overseers, immediately after receiving said orders, to proceed at once to warn out all persons liable under section one of this act, giving notice of the time and place of meeting, and the tools to be used, and the kind of work expected to be performed, and all work shall be done and performed under the direction of the road-overseers.

SEC. 3. Any persons over eighteen years of age warned out as is provided in this act may pay the road-overseer the sum of one dollar per day for the time so warned out, and in case any person shall fail to perform labor under this act or paying the sum of one dollar when so warned out, shall be adjudged guilty of a misdemeanor, and on conviction shall be fined the sum of three dollars for each day so failing or refusing, and the moneys so collected shall be expended by the road-overseers in the destruction of grasshoppers in their respective road-districts.

SEC. 4. For the purpose of carrying out the provisions of this act the road-overseer is authorized to enter upon the premises of any person lying within the township where such order of the township trustee is in force, with a sufficient number of hands and teams to perform such labor as he may deem necessary for the public good.

SEC. 5. It shall be the duty of the secretary of the State board of agriculture, immediately after the passage of this act, to compile in circular form all information relating to the manner and means heretofore used for the extermination of grasshoppers, and send at least ten copies of the same to each township trustee in the State.

SEC. 6. This act shall take effect and be in force from and after its publication once in the Commonwealth.

Approved March 6, 1877.

AN ACT providing for a concert of action by senatorial districts for the destruction of grasshoppers.

Be it enacted by the legislature of the State of Kansas :

SECTION 1. That in any senatorial district in the State of Kansas where trouble is anticipated from the ravages of young grasshoppers in the year 1877, and any subsequent year thereafter, it shall be lawful for the counties in said senatorial district to co-operate together in the way and manner herein provided for the destruction of the same.

SEC. 2. The chairman of the board of county commissioners in the county having the largest number of inhabitants in a senatorial district, where two or more counties form said district, may notify the chairman of each of the boards of county commissioners of the remaining counties in said district of the time and place when the chairmen of the several boards of commissioners of the respective counties forming said senatorial district shall hold a joint meeting.

SEC. 3. At such meeting two of their number shall be chosen to act as chairman and secretary, and the proceedings of the meeting shall be published in all the newspapers printed in the senatorial district.

SEC. 4. Said meeting shall designate the manner of procedure by road-overseers, and what day or days the young grasshoppers should be driven from the cultivated land on the unburnt prairie or places of destruction, and shall also designate on what day or days the grasshoppers shall be destroyed, by burning or otherwise, in said senatorial district, giving at least ten days' notice of the same by publishing in the newspapers of the said district.

SEC. 5. The board of commissioners of each county shall notify the road-overseers of said county of the time fixed upon by the joint meeting for the driving and burning, or destroying by other means, of the grasshoppers in the district; said notice to be given to said overseers as soon as practicable after the same shall have been determined by the joint meeting.

SEC. 6. Said road-overseer shall immediately notify the residents of his road-district of the time designated and the manner of procedure, in order to carry out the provisions of this act. He shall also specify what tools or implements will be required of each resident in performing the labor required of him; and such notice may be enforced the same as in the acts authorizing road-overseers to warn out the residents to perform road-labor; and a refusal shall subject such persons refusing to the same penalties as are provided by law in such cases.

SEC. 7. The road-overseer shall direct the manner of performing the labor, and have the supervision of the same, and shall keep a list of the names of those who shall perform labor, and shall certify the number of days' work performed by each, and shall place such certified list in the possession of the board of county commissioners of his county.

SEC. 8. It shall be lawful for two or more senatorial districts to co-operate together under the provisions of this act on a basis of action which they may agree upon.

SEC. 9. This act shall take effect and be in force from and after its publication in the daily Commonwealth.

Approved March 7, 1877.

MINNESOTA.

AN ACT to provide for the destruction of grasshoppers and their eggs.

Be it enacted by the legislature of the State of Minnesota :

SECTION 1. There shall be paid by this State, out of any moneys in the treasury thereof not otherwise appropriated, to any person or persons living within any of the counties in said State afflicted by grasshoppers, the following bounties for catching and destroying of the same and the destruction of their eggs :

SEC. 2. The sum of one dollar per bushel for grasshoppers caught previous to the twenty-fifth day of May next. The sum of fifty cents per bushel from the said twenty-fifth day of May to the tenth day of June. The sum of twenty-five cents per bushel from the said tenth day of June to the first day of July; and twenty cents per bushel from the said first day of July to the first day of October next.

SEC. 3. There shall also be paid, in the same manner, the sum of fifty cents per gallon for any and all grasshopper-eggs taken and destroyed by any person or persons.

SEC. 4. There shall be appointed by the governor a competent person in each township in the several counties so afflicted by grasshoppers, who shall be a resident of the township for which he shall be appointed, to receive, measure, and destroy the grasshoppers and their eggs delivered to him by any person or persons catching and taking the same, which said person so appointed shall take and subscribe an oath for the faithful discharge of his duties, which oath, together with the certificate of appointment, shall be filed in the office of the county auditor, and he shall receive as compensation for his services such sum as the county commissioner may determine, to be paid out of the funds of the county, and in case of necessity, when he cannot perform the duties of his office, said measurer shall have authority and be empowered to appoint a suitable and competent person his assistant, which assistant shall be required to take and subscribe the same oath and be subject to the same penalties as the said measurer.

SEC. 5. The person receiving and measuring the grasshoppers and their eggs as aforesaid shall measure and immediately and effectually destroy the same, and keep an exact account of all the grasshoppers and their eggs received by him and the name of the persons delivering the same, and shall issue a certificate for the amount of grasshoppers and their eggs to the person delivering the same. And he shall, at the end of each week after commencing to receive and measure the same, and on the second day of June, on the eleventh day of said month, on the second day of July, and on the second day of October next, make a report to the county auditor of all the grasshoppers and their eggs measured by him, the number of certificates issued, and the names of the persons to whom he issued the same; and the county auditor shall examine the same and file it in his office, which report shall be subject to public inspection; and the county auditor shall, at the end of each week after he shall have received the first of said reports, transmit a copy of the said reports to the governor, who shall, as soon as the sum hereby appropriated shall have been expended in the payment of said bounties, notify all persons interested therein of such fact by a publication of such notice in some newspaper printed and published at the city of Saint Paul, in said State of Minnesota, for three successive days.

SEC. 6. For a failure on the part of said measurer to perform any of his duties under this act, or for any mismeasurement of such grasshoppers and their eggs, he shall be deemed to be guilty of a misdemeanor, and be subject to pay a fine of not less than ten dollars nor more than one hundred dollars, or be imprisoned in the county jail for a term of not less than thirty nor more than ninety days, in a suit or proceeding to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law in other cases of misdemeanor.

SEC. 7. Upon the presentation of such certificate to the county auditor, he shall issue a certificate to the person entitled thereto for the amount due him, (a form of which certificate shall be furnished by the State auditor,) and shall make an order upon the State auditor for the amount thereof, and the State auditor shall draw his warrant upon the State treasurer for that amount in favor of the parties holding said certificates, which shall be paid by the State treasurer on presentation: *Provided*, That all certificates presented to the county auditor for payment shall be by him filed and preserved in his office, and he shall present such certificates to the board of county commissioners, who shall audit the same in the manner now provided by law for auditing accounts against counties; and no money shall be drawn from the State treasury until such certificates have been audited and allowed in the manner herein provided. And that no money shall be paid under the provisions of this act at any time prior to the fifteenth day of July, A. D. 1877, and that the money hereby appropriated shall only apply to certificates duly made and filed with the auditor of State or before said day; that at the time after the State auditor shall ascertain the total amount of all claims and certificates so filed, and if the same shall exceed in amount the sum of one hundred thousand dollars, then the said claims shall be paid pro rata, and no other or greater amount than said sum of one hundred thousand dollars shall ever be paid under the provisions of this act: *And provided further*, That if the amount hereby appropriated is not sufficient to pay the certificates in full, the balance shall be paid by the counties respectively, according to the amount due on said certificates as issued by such county.

SEC. 8. Every male inhabitant of the several townships in the said afflicted counties, being above the age of twenty-one years and under the age of sixty years, excepting paupers, idiots, and lunatics, shall be assessed by the board of supervisors of said township to work one day in each week in said township, during the period hereinafter mentioned for the paying of bounties, for the purpose of catching and destroying grasshoppers and their eggs, for five weeks from the time said grasshoppers shall become large enough to be taken; and the amount of work to be so assessed shall not exceed five days in all.

SEC. 9. The supervisors aforesaid shall make a list of the names of all persons against whom said tax shall have been assessed, and place in a column opposite each name on said list the amount of labor assessed against such person, and shall direct the town clerk to make a certified copy of each list, after which the town clerk shall deliver the several copies to the respective overseers of the highways of said townships.

SEC. 10. The overseers of highways shall give at least two days' notice to all persons assessed to work as aforesaid, living within the limits of their respective districts, of the time and places where and when they are to appear for that purpose, and with what implements.

SEC. 11. Every person liable to work, as provided for in this act, may commute for the same at the rate of one dollar per day, in which case such commutation-money shall be paid to the chairman of the board of supervisors, to be applied and expended by him for the destruction of grasshoppers and their eggs, and he shall be authorized and required to hire and engage some suitable and efficient person to work in the place of said person so commuting, and to pay him the sum of one dollar per day for his services; and every person intending to commute for his assessment shall, within five days after he is notified to appear and work as aforesaid, pay the commutation-money for the work required of him by said notice, and the commutation shall not be considered as made until such money is paid.

SEC. 12. Every person so assessed and notified, who shall willfully neglect or refuse to commute or work as provided by this act, shall be guilty of a misdemeanor, and shall, on conviction thereof, be liable to pay a fine of not less than two dollars nor more than ten dollars, or by imprisonment in the county jail not more than ten days, or both, in the discretion of the court, in a suit to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law for prosecutions of misdemeanors.

SEC. 13. There shall be appropriated, out of any moneys in the treasury of this State not otherwise appropriated, for the purpose of carrying out the provisions of this act, the sum of one hundred thousand dollars.

SEC. 14. The board of county commissioners of any county in this State afflicted by grasshoppers shall have the right, if in their judgment they see fit, to employ one or more persons in each township in said county, with such implements or mechanical contrivances as may prove most efficient, to destroy the grasshoppers from the first day of April to the first day of August in each year, paying such persons either by the day or a specified sum for the amount captured and destroyed. The compensation of such person shall be paid out of the general fund of the county: *Provided further*, That parties employed and paid by the county commissioners shall not receive any other or further compensation under the provisions of this act.

SEC. 15. This act shall take effect and be in force from and after its passage.

Approved March 1, 1877.

NEBRASKA.

AN ACT to provide for the destruction of grasshoppers.

Whereas the State of Nebraska has, for the past three years, been devastated by the grasshoppers, thereby greatly injuring the agricultural and commercial interests of the State; and whereas these interests are liable to be seriously damaged in the future by the recurrence of the pests aforesaid: therefore,

Be it enacted by the legislature of the State of Nebraska:

SECTION 1. That the supervisors of each road district in this State shall, at the time when the grasshoppers shall have been hatched out, and before the same shall become full fledged and fly, notify each able-bodied male resident of his district, between the ages of sixteen and sixty years, to perform two days' labor, at such time and at such place and in such manner as shall by said supervisors be deemed most efficient in the destruction of the grasshoppers; said notices shall be given in the same manner as is provided by law for the notice to work upon public highways.

SEC. 2. Cities of the first and second class shall be governed by the provisions of this act, and it shall be the duty of the mayor of such cities to appoint, not exceeding two supervisors for each ward, to oversee the labor to be performed under the provisions of this act.

SEC. 3. In case it shall appear that two days' work is not sufficient to destroy the grasshoppers in any district or ward, and it shall further appear that more time can be profitably employed in the destruction of the grasshoppers, the supervisors of each ward or road district may require from the persons liable to the provisions of this act, not exceeding ten days' labor in addition to the time hereinbefore mentioned, and it shall be the duty of such supervisor to give to each person who shall have performed labor under the provisions of this section a receipt for the number of days' labor performed, and the supervisor shall upon oath report to the city or county authorities the names and amount of labor performed by each person.

SEC. 4. It shall be the duty of all persons subject to the provisions of this act to attend when notified as herein provided, and labor under the direction of the supervisor of their respective district or ward. Any person who, after being notified, shall refuse, neglect, or fail to comply with the provisions of this act, shall forfeit and pay to the county or city treasurers, as the case may be, the sum of ten dollars, together with costs of suit, which sum shall be collected by suit before any justice of the peace within the county, in an action to be brought in the name of the city or county.

SEC. 5. The supervisor shall report, under oath, to the city or county authorities the names of all persons who shall have refused or failed to comply with the provisions of this act.

SEC. 6. This being a case of emergency, this act shall take effect and be in force from and after its passage.

SUMMARY OF REMEDIES.

The publication of a second edition of this bulletin permits the summing up of the directions contained therein, with some additional experience recently gained in the field.

The means of destroying the young locusts necessarily vary somewhat with the nature of the soil and of the crops, and we give in this connection principles rather than details. For convenience these may be classified into: 1, burning; 2, crushing; 3, trapping; 4, catching; 5, the use of destructive agents.

1. *Burning.*—In a prairie and wheat-growing country like much of that which this locust devastates, burning is perhaps the best means of warfare against the young. These, for some time after they hatch, may be driven, as already suggested, into windrows or heaps of straw scattered around and through a field and burned. During cold, damp weather they will, of their own accord, congregate under such shelter, and may sometimes be exterminated by burning, where no driving is necessary. As to burning the prairie in the spring, while there is much to be said pro and con, it is, all things considered, beneficial in this connection. Scarcely any eggs are laid in rank prairie, and the impression that locusts are slaughtered by myriads in burning extensive areas, is a false one. It is beneficial principally around cultivated fields and roadsides,

from which the locusts may be driven, or will of themselves pass for the shelter the prairie affords.

When a wheat field is attacked by the young in their usual method of commencing on one side and eating somewhat regularly across it, many may be destroyed by spreading straw over them in the evening about the time they cease eating. They will collect upon this, and if it is fired very early in the morning many will be destroyed before they commence moving.

The burning of extensive prairies after the bulk of the locusts hatch destroys the nests and eggs of some game birds which feed upon the locusts, but the birds themselves always escape and nest again; whereas many noxious insects, like the chinch bug, are killed; so that, even leaving the locust question out of consideration, the burning would yet prove advantageous to man.

2. *Crushing.*—Can be resorted to with advantage only in exceptional cases, where the ground is smooth and hard.

3. *Trapping.*—This is very effectual, especially when the insects are making their way into a field from roads and hedge-sides. The use of converging nets, as described on page 6, is important in this connection.

Ditching or trenching will come under this head; and after the insects have commenced to travel in schools, proper ditching is the most effectual protection, as recommended on page 5.

There will be much premature judgment passed upon ditching by those who employ it against the very small and newly-hatched locusts which more easily crawl up a perpendicular bank than the larger ones; but we speak from past experience, and would urge all who are threatened, to employ this mode of protection from now on.

Where the soil is tenacious, and water or a little kerosene can be used at the bottom, all the better; and the side to the garden, orchard, nursery or field to be protected should be kept friable by means of a fine rake. In proportion as the soil is loose and apt to fill up by strong winds, ditching will fail.

4. *Catching.*—There are innumerable mechanical contrivances for this purpose. Many useful designs have already been submitted to the Commission. The cheapest and most satisfactory are those intended to bag the insects. A frame two feet high and of varying length, according as it is to be drawn by men or horses, with a bag of sheeting tapering behind and ending in a small bag or tube, say one foot in diameter and two or three feet long, with a fine wire door at the end to admit the light and permit the dumping of the insects, will do admirable work. The insects gravitate toward the wire screen, and when the secondary bag is full they may be emptied into a pit dug for the purpose. These bagging-machines will prove most serviceable when grain is too high for the kerosene pans, presently to be described.

A curious suction-fanning machine has been invented by Mr. J. C. King, of Boulder, Colo., and may be mentioned in this connection. A strong draft sucks the insects up through an elongate mouth with lips that run near the ground, and draws them up through two funnels and knocks them to pieces. We have seen the working of that in Mr. T. C. Henry's possession at Abilene, Kans. It is an admirable invention, and may be improved so as to be of great service; but on account of its expense will scarcely compete with the more simple methods.

5. *Use of destructive agents.*—Kerosene is the most effective. It may be used in any of its cruder forms. In Colorado they use it to good advantage on the water in their irrigating-ditches, and it may be used anywhere in pans or in saturated cloths, stretched on frames, drawn

over a field. A good and cheap pan is made of ordinary sheet-iron, eight feet long, eleven inches wide at the bottom, and turned up a foot high at the back and an inch high at the front. A runner at each end, extending some distance behind, and a cord attached to each front corner, complete the pan, at a cost of about \$1.50. A similar pan on wheels, and moved by a handle behind, may be operated by a single person to good advantage.

We have known from seven to ten bushels of young locusts caught with one such pan in an afternoon. It is easily pulled by two boys, and by running several together in a row, one boy to each outer rope and one to each contiguous pair, the best work is performed at the least labor. Heavier or longer pans, to be drawn by horses, should have transverse partitions to avoid spilling of the liquid; also more runners. The oil may be used alone so as to just cover the bottom, or on the surface of water, and the insects strained through a wire ladle. When the insects are very small, one may economize in kerosene by lining the pan with saturated cloth; but this becomes less efficient afterward, and frames of cloth saturated with oil do not equal the pans. Where oil has been scarce, some persons have substituted concentrated lye, but when used strong enough to kill, it costs about as much as the oil. The oil-pans can only be used when the crops to be protected are small.

Small pans for oil, or for burning on the principle of that made by Mr. Hetzel, mentioned on page 7, attached to an obliquing pole or handle, do excellent service in gardens.

Recently a machine for destroying the young locusts has come into extensive use in Minnesota. This consists of a sheet-iron pan, with the back elevated and curved; it is covered with coal-tar, which fastens the insects falling upon it. When the tar is covered with insects they are burned. These pans may be drawn or pushed, as suggested in reference to the kerosene-pans.

Published June 12th, 1877.



DEPARTMENT OF THE INTERIOR.
U. S. GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.
F. V. HAYDEN, U. S. GEOLOGIST-IN-CHARGE.

BULLETIN

OF

THE UNITED STATES

ENTOMOLOGICAL COMMISSION.

ON THE NATURAL HISTORY OF THE ROCKY MOUNTAIN LOCUST,
AND ON THE HABITS OF THE YOUNG OR UNFLEDGED INSECTS
AS THEY OCCUR IN THE MORE FERTILE COUNTRY IN
WHICH THEY WILL HATCH THE PRESENT YEAR.

No. 2.

SECOND EDITION.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
June, 1877.

P R E F A C E .

The present Bulletin has been prepared in accordance with the purpose of the Commission to issue Bulletins containing special information that is of interest and sought for at the time of publication. In preparing this Bulletin, No. 2, we have made large use of Professor Riley's Entomological Reports to the State of Missouri, and this the more readily that they are in limited circulation outside of that State, and because the legislature has made no provision for the distribution of the last.

The map at the end will illustrate in a general way the country that will most severely suffer, and the eastern limit of injury the present year.

C. V. RILEY,
A. S. PACKARD, JR.,
CYRUS THOMAS,
Commissioners.

ON THE NATURAL HISTORY OF THE ROCKY MOUNTAIN LOCUST, AND ON THE HABITS OF THE YOUNG OR UNFLEDGED INSECTS AS THEY OCCUR IN THE MORE FERTILE COUNTRY IN WHICH THEY WILL HATCH THE PRESENT YEAR.

CHARACTERS OF THE SPECIES.

Though often confounded with other species, the Rocky Mountain Locust may be recognized by the following characters: It measures on an average about $1\frac{1}{2}$ inches from the head to the tip of the closed wings, and the wings extend about one-third their length beyond the tip of the abdomen. The color is variable, but the more common specimens are yellowish-white beneath; glaucous or cabbage-blue across the breast

Fig. 1.



ROCKY MOUNTAIN LOCUST.

Fig. 2.



RED-LEGGED LOCUST.

and about the mouth parts; pale-bluish, often with shades of purple, on the sides of the head and thorax and on the front of the face; olive-brown on the top of the head and thorax; pale beneath, more or less bluish above and marked with black, especially toward the base, on the abdomen. The front wings have the ground-color pale grayish-yellow, inclining to green, and their spots and veins brown; the hind wings, except a yellowish or brownish shade at apex and along the front edge and a green tint at base, are transparent and colorless, with the veins brown. The front and middle legs are yellowish. The hind legs have the thighs striped with pale glaucous and reddish on the outside and upper half of inside, with four broad black or dusky marks on the upper edge, the terminal one extending beneath around the knee. The shanks are coral-red, with black spines; the feet somewhat paler, with black claws; antennæ pale yellow; palpi tipped with black. In the dead specimens all these colors become more dingy and yellow. It very

Fig. 3.



ROCKY MOUNTAIN LOCUST.—Anal characters of male; a, side view; b, c, hind and top views, of tip.

Fig. 4.



RED-LEGGED LOCUST.—Anal characters of male; a, side view; b, c, hind and top views, of tip.

closely resembles, and is often confounded with the Red-legged Locust (*Caloptenus femur-rubrum*, De Geer), a species common to the whole middle portion of the continent from the Atlantic to the Rocky Mountains, which, though capable of short flights, never commit the same havoc. This last is, on an average, smaller, darker, with shorter and less conspicuously spotted wings (seldom extending more than one-sixth of their length beyond the tip of the abdomen), and the last abdominal joint of the male (Fig. 4) is bluntly cut off at the top, and not tapering and notched as in the *C. spretus* (Fig. 3).

THE EGGS.

The question as to how best to treat the soil or to manage the eggs so as to most easily destroy their vitality is a most important and practical one. Everything, therefore, that relates to the eggs—the manner of deposition, the character of the mass, the method of hatching, &c., even to the minutest details—becomes important and is worthy of careful study.

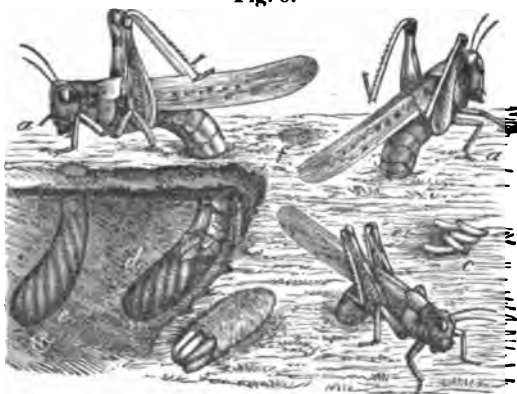
WHERE THE EGGS ARE LAID.

The eggs may be laid in almost any kind of soil, but by preference they are laid in bare, sandy places, especially on high, dry ground, which is tolerably compact and not loose. It is generally stated that they are not laid in meadows and pastures, and that hard road-tracks are preferred; in truth, however, meadows and pastures, where the grass is closely grazed, are much used for ovipositing by the female, while on well-traveled roads she seldom gets time to fulfill the act without being disturbed. Thus a well-traveled road may present the appearance of being perfectly honey-combed with holes, when an examination will show that most of them are unfinished, and contain no eggs; whereas a field covered with grass-stubble may show no signs of such holes and yet abound with eggs. Furthermore, the insects are more readily noticed at their work along roads and roadsides than in fields, a fact which has also had something to do in forming the popular impression. Newly broken or ploughed land is not liked; it presents too loose a surface. Moist or wet ground is generally avoided for the purpose under consideration. During the operation the female is very intent on her work and may be gently approached without becoming alarmed, though when suddenly disturbed she makes great efforts to get away and extricates her abdomen in the course of a few seconds, the time depending on the depth reached.

HOW THE EGGS ARE LAID.

The female, when about to lay her eggs, forces a hole in the ground by means of the two pairs of horny valves which open and shut at the tip of her abdomen, and which, from their peculiar structure, are admirably fitted for the purpose.

Fig. 5.

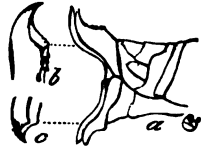


ROCKY MOUNTAIN LOCUST.—a, a, a, female in different positions, ovipositing; b, egg-pod extracted from ground, with the end broken open; c, a few eggs lying loose on the ground; d, e, show the earth partially removed, to illustrate an egg-mass already in place, and one being placed; f, shows where such a mass has been covered up.

(See Fig. 6, where b, c show the structure of one of each of the upper and lower valves). With the valves closed she pushes the tips in the ground, and by a series of muscular efforts and the continued opening and shutting of the valves, she drills a hole until in a few minutes (the time varying with the nature of the soil) nearly the whole abdomen is buried. The abdomen stretches to its utmost for this purpose, especially at the middle, and the hole is generally a little curved, and always more or less ob-

lique (Fig. 5, *d*). Now with hind legs hoisted straight above the back, and the shanks hugging more or less closely the thigh, she commences ovipositing. If we could manage to watch a female during the arduous work of ovipositing we should find that, when the hole is once drilled, there commences to exude at the dorsal end of the abdomen, from a pair of sponge-like exsertile organs (Fig. 7, *h*) that are normally retracted and hidden beneath the super-anal plate (Fig. 7, *i*), near the cerci, a frothy, mucous matter which fills up the bottom of the hole. Then with two pairs of valves brought close together, an egg would be seen to slide down the oviduct (*j*) along the ventral end of the abdomen, and, guided by a little finger-like style,* (*g*) pass in between the horny valves (which are admirably constructed not only for drilling, but for holding and conducting the egg to its appropriate place) and issue at their tips amid the mucous fluid already spoken of. Then follows a period of convulsions, during which more mucous material is elaborated, until the whole end of the body is bathed in it, when another egg passes down and is placed in position. These alternate processes continue until the full complement of eggs are in place, the number ranging from 20 to 35, but averaging about 28. The mucous matter binds all the eggs in a mass, and when the last is laid the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact and cellulose mass of the same material, which, though light and easily penetrated, is more or less impervious to water, and forms a very excellent protection (Fig. 8, *d*).

Fig. 6.



ROCKY MOUNTAIN LOCUST.—Anal characters of female, showing horny valves.

Fig. 7.



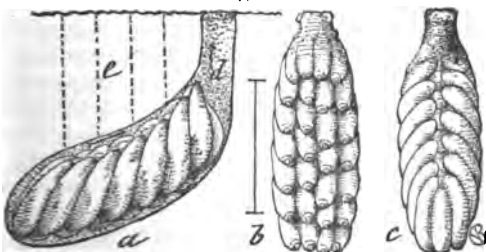
OVIPOSITION OF ROCKY MOUNTAIN LOCUST.

PHILOSOPHY OF THE EGG-MASS.

To the casual observer the eggs of our locust appear to be thrust indiscriminately in the hole made for their reception. A more careful study of the egg-mass or egg-pod will show, however, that the female took great pains to arrange them, not only so as to economize as much space as possible consistent with the form of each egg, but so as to best facilitate the escape of the young locust; for if any of the bottom eggs were to hatch before the upper or anterior ones, their issue would, in their efforts to escape, disturb and injure the other eggs, were there no provision against such a possibility.

The eggs are, indeed, most carefully placed side by side in four rows, each row generally containing seven. They oblique a little crosswise of the cylinder (Fig. 8, *a*). The posterior or narrow end, which issues first from the oviduct, is thickened, and generally shows two pale rings around the darker tip (Fig. 9, *a*). This is pushed close against the bottom of the burrow, which, being cylindrical, does not permit the outer or two side rows to be pushed quite so far down as the two inner rows,

Fig. 8.



EGG-MASS OF ROCKY MOUNTAIN LOCUST.—*a*, from the side, within burrow; *b*, from beneath; *c*, from above—enlarged.

* This is a simple process or extension of the sternite, and may be known as the egg-guide, or *gubernaculum ovi*.

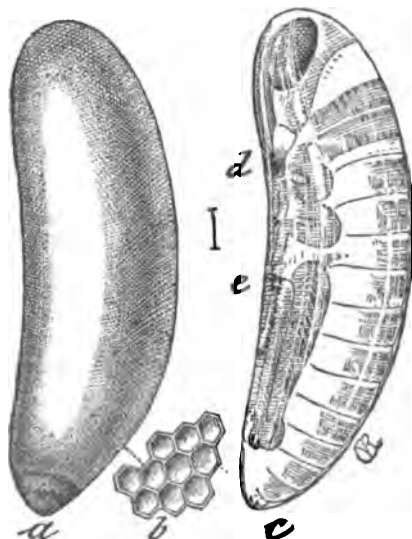
and for the very same reason the upper or head ends of the outer rows are necessarily bent to the same extent over the inner rows, the eggs when laid being somewhat soft and plastic. There is, consequently, an irregular channel along the top of the mass (Fig. 8, c), which is filled only with the same frothy matter which surrounds each egg and occupies all the other space in the burrow not occupied by the eggs. The whole plan is seen at once by a reference to the accompanying figure, which represents, enlarged, a side view of the mass within the burrow (a), and a bottom (b) and top (c) view of the same with the earth which adheres to it removed.

HOW THE YOUNG LOCUST ESCAPES FROM THE EGG.

Carefully examined, the egg-shell is found to consist of two layers. The outer layer, which is thin, semi-opaque, and gives the pale cream-yellow color, is seen by aid of a high magnifying power to be densely, minutely, and shallowly pitted, or, to use still more exact language, the whole surface is netted with minute and more or less irregular hexagonal ridges (Fig. 9, a, b). The inner layer (the chorion) is thicker, of a deeper yellow, and perfectly smooth. It is also translucent, so that, as the hatching period approaches, the form and members of the embryo may be distinctly discerned through it. The outer covering is easily ruptured, and is rendered all the more fragile by freezing; but the inner covering is so tough, that a very strong pressure between one's thumb and finger is required to burst it. How, then, will the embryo, which fills it so compactly that there is scarcely room for motion, succeed in escaping from such a prison? The rigid shell of the bird's egg is easily cracked by the beak of its tenant; the hatching caterpillar, curled within its egg-shell, has room enough to move its jaws and eat its way out; the egg-coverings of many insects are so delicate and frail, that

the mere swelling of the embryo affords means of escape; those of others so constructed that a door flies open or a lid lifts by a spring whenever pressure is brought to bear; in some, two halves open, as in the shell of a muscle; while in a host of others the embryo is furnished with a special structure called the egg-burster or egg-tooth (*ruptor ovi*), the office of which is to cut or rupture the shell, and thus afford means of escape. But our young locust is deprived of all such contrivances. Nature accomplishes the same end in many different ways. She is rich in devices. The egg increases considerably in size before hatching, and the shell necessarily becomes weaker as it stretches. At last, by the muscular efforts of the nascent locust and the swelling of its several parts, especially about the head and mouth, the shell gives way, generally splitting along the anterior ventral part. All the eggs in a given mass burst very much at one

Fig. 9.



EGG OF ROCKY MOUNTAIN LOCUST.—a, showing sculpture of outer shell; b, the same very highly magnified; c, the inner shell just before hatching; d, e, points where it ruptures.

and the same time, and in that event the lowermost individuals await the escape of those in front of them, which first push their way out through the neck of the burrow (Fig. 8, *d*) provided by the parent. They all escape one after the other through one small hole, which is scarcely noticeable in the field.

Such is the usual mode of hatching; but when the young from the lower eggs hatch first, or when the upper eggs perish and leave the lower ones sound, as is not unfrequently the case, the exit is nevertheless easily made along the channel already described (Fig. 8, *c*).

By a series of undulating movements the nascent larva soon works itself entirely out of the egg, when it easily makes its way along the channel already described, without in the least interfering with the other eggs, and finally forces a passage-way up through the mucous filling in the neck of the burrow (Fig. 8, *d*). Once fully escaped from the soil, it rests from its exertions, but for a short time only. Its task is by no means complete; before it can feed or move with alacrity it must molt a pellicle* which completely incases every part of the body. This it does in the course of three or four minutes, or even less, by a continuance of the same contracting and expanding movements which freed it from the earth, and which now burst the skin on the back of the head. The body is then gradually worked from its delicate covering until the last of the hind legs is free, and the exuvium remains, generally near the point where the animal issued from the ground, as a little, white, crumpled pellet. Pale and colorless at first, the full-born insect assumes its dark-gray coloring in the course of half an hour.

From this account of the hatching process, we can readily understand why the female in ovipositing prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

The covering which envelops the little animal when first it issues from the egg, though quite delicate, undoubtedly affords protection in the struggles of birth from the burrow, and it is an interesting fact that while it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed if, from one cause or other, there is failure to escape from the soil, though the young locust may be struggling for days to effect an escape.

While yet enveloped in this pellicle, the animal possesses great forcing and pushing power, and if the soil be not too compact, will frequently force a direct passage through the same to the surface, as indicated at the dotted lines, Fig. 8, *e*. But it can make little or no headway, except through the appropriate channel (*d*), where the soil is at all compressed. While crowding its way out, the antennæ and four front legs are held in much the same position as within the egg, the hind legs being generally stretched. But the members bend in every conceivable way, and where several are endeavoring to work through any particular passage, the amount of squeezing and crowding they will endure is something remarkable. Yet if by chance the protecting pellicle is worked off before issuing from the ground, the animal loses all power of further forcing its way out. The instinctive tendency to push upward is also remarkable. In glass tubes, in which the eggs have been placed in order to watch the method of hatching, the young always turned their heads and pushed toward the bottom whenever the tubes were turned mouth downward; while in tin boxes, where the eggs were placed at different depths in the ground, the young never descended, even when

* This pellicle (the *amnion*) is common to most insects, but so far as we have observed it is shed after leaving the chorion principally by the orthoptera and neuroptera.

they were unable to ascend on account of the compactness of the soil above.

TIME OF HATCHING.

The date at which the eggs hatch varies with the earliness or lateness of the spring, and is moreover quite irregular, some hatching in the same locality when the first-hatched locusts are getting wings. As a general rule, however, the bulk of the eggs hatch out in the different latitudes about as follows:

In Texas, from the middle to last of March.

In the southern portion of Missouri and Kansas, about the second week in April.

In northern parts of Missouri and Kansas and southern sections of Iowa and Nebraska, the latter part of April and first of May.

In Minnesota and Dakota, the usual time of hatching ranges from early in May in the southern portions to the third week in the northern extremity.

In short, the bulk of the insects hatch, in ordinary seasons, about the middle of March in latitude 35° and continue to hatch most numerous about four days later with each degree of latitude north, until along the forty-ninth parallel the same scenes are repeated that occurred in Southern Texas seven or eight weeks before.

In Montana and Manitoba, from the middle of May to the first of June.

TRANSFORMATIONS.

When first hatched the little locust is quite pale, but soon becomes mottled with gray and brown. Except in having a shorter, narrower

Fig. 10.



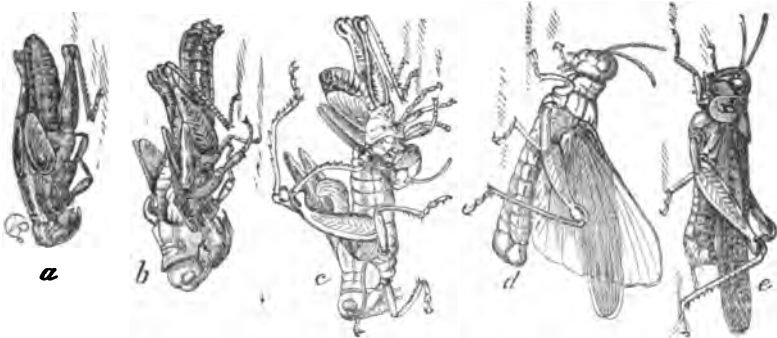
ROCKY MOUNTAIN LOCUST.—a, a newly hatched larva; b, full-grown larva; c, pupa.

prothorax, sloping roof-fashion to a median ridge, and in lacking wings, the young locust scarcely differs in structure from its parent; and the perfect, winged form is gradually assumed through a series of five molts, during the first four of which the wing-pads become larger, and during the last, from the pupa (Fig. 10, c) to the perfect state, the thorax becomes flattened, the wings are acquired and the insect ceases to grow and is ready to procreate. The time required from hatching till the wings are obtained averages from six weeks to two months.

In order to illustrate the interesting process of molting we will trace an individual through the last molt—from the pupa to the winged insect—as it is the most difficult, and on account of the larger size of the animal, most easily watched. The other molts are very similar, except that the wing-pads increase but moderately in size with each. When about to acquire wings the pupa crawls up some post, weed, grass-stalk, or other object, and clutches such object securely with the hind feet, which are drawn up under the body. In doing so the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennæ drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially between the wing-pads, is noticed to swell. Presently the skin along this swollen portion splits right along the middle of the head and thorax, starting by a transverse-

curved suture between the eyes, and ending at the base of the abdomen. Let us now imagine that we are watching one from the moment of this

Fig. 11.



ROCKY MOUNTAIN LOCUST.—Process of acquiring wings; *a*, pupa with skin just split on the back; *b*, the imago extruding; *c*, the imago nearly out; *d*, the imago with wings expanded; *e*, the imago with all parts perfect.

splitting, and when it presents the appearance of Fig. 11, *a*. As soon as the skin is split, the soft and white fore-body and head swell and gradually extrude more and more by a series of muscular contortions; the new head slowly emerges from the old skin, which, with its empty eyes, is worked back beneath; the new feelers and legs are being drawn from their casings, and the future wings from their sheaths. At the end of six or seven minutes our locust—no longer pupa and not yet imago—looks as in Fig. 11, *b*, the four front pupa-legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that command over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor—of swelling and contracting—with an occasional brief respite, the antennæ and the four front legs are freed, and the full and crimped wings extricated. The soft front legs rapidly stiffen, and, holding to its support as well as may be with these, the nascent locust employs whatever muscular force it is capable of to draw out the end of the abdomen, and its long hind legs (Fig. 11, *c*). This in a few more minutes it finally does, and with gait as unsteady as that of a new-dropped colt, it turns round and clammers up the side of the shrunken, cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength—the crooked limbs straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are at first rolled longitudinally to a point, and as they expand and unroll, the hind wings, which are tucked and gathered along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags (Fig. 11, *d*). From this point on, the broad hind wings begin to fold up like fans beneath the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents an aspect fresh and bright (Fig. 11, *e*). If now we examine the cast-off skin we shall find every part entire with the exception of the rupture which originally took place on the back; and it would puzzle one who had not

witnessed the operation to divine how the now stiff hind shanks of the mature insect had been extricated from the bent skeleton left behind. They are in fact drawn over the bent knee-joint, so that during the process they have been bent double throughout their length. They were as supple at the time as an oil-soaked string, and for some time after extrication they show the effects of this severe bending by their curved appearance.

The molting, from the bursting of the pupa-skin to the full adjustment of the wings and straightening of the legs of the perfect insect, occupies less than three-quarters of an hour, and sometimes but half an hour. It takes place most frequently during the warmer hours of the morning, and within an hour after the wings are once in position the parts have become sufficiently dry and stiffened to enable the insect to move about with ease, and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws. The molting period, especially the last, is a very critical one, and during the helplessness that belongs to it the unfortunate locust falls a prey to many enemies which otherwise would not molest it, and not unfrequently to the voracity of the more active individuals of its own species.

As already stated, there are five molts exclusive of that which takes place upon leaving the egg. In the first stage—that following the egg—the wing-pads are not visible; in the second (after the first molt) they project but little beyond the meso- and meta-thorax, differ but little in size, and are directed downward, lying separately close to the body; in the third stage (after second molt) they are directed upward, the hind covering and hiding more or less the front pair, and the joints bearing them retreating more beneath the prothorax; in the fourth stage (after third molt) they are enlarged as seen in the pupa, and with the fourth molt the fifth or perfect stage is attained.

HABITS OF THE YOUNG OR UNFLEDGED LOCUSTS.

The habits of the young insects as they occur in the country south of the forty-fourth parallel are as follows: Although possessed of remarkably active powers from the moment they leave the egg, yet so long as provision suffices for them on their hatching-grounds the young remain almost stationary and create but little apprehension. As soon, however, as the supply of food in these situations is exhausted, they commence to migrate, frequently in a body a mile wide, devouring as they advance all the grass, grain, and garden-truck in their path. The migrating propensity is not developed until after the first molt. Up to that time they are content to huddle in warm places, and live, for the most part, on weeds, and especially on the common Dog-fennel or May-weed (*Maruta*) where it is present.

The young locusts display gregarious instincts from the start, and congregate in immense numbers in warm and sunny places. They thus often blacken the sides of houses or the sides of hills. They remain thus huddled together during cold, damp weather. When not traveling, and when food is abundant, or during bad, or rainy weather, they are fond of congregating on fences, buildings, trees, or anything removed from the moist ground. They also prefer to get into such positions to undergo their different molts.

Their power for injury increases with their growth. At first devouring the vegetation in particular fields and patches in the vicinity of their birth-places, they gradually widen the area of their devastation, until at last they devour every green thing over extensive districts.

Whenever they have thus devastated a country they are forced to feed upon one another, and perish in immense numbers from debility and starvation. Whenever timber is accessible they collect in it, and after cleaning out the underbrush, feed upon the dead leaves and bark. A few succeed in climbing up into the rougher-barked trees, where they feed upon the foliage, and it is amusing to see with what avidity the famished individuals below scramble for any fallen leaf that the more fortunate mounted ones may chance to sever. This increase in destructiveness continues until the bulk of the locusts have undergone their larval molts and attained the pupa state. The pupa, being brighter colored, with more orange than the larva, the insects now look, as they congregate, like swarms of bees. From this time on they begin to decrease in numbers, though retaining their ravenous propensities. They die rapidly from disease and from the attacks of natural enemies, while a large number fall a prey, while in the helpless condition of molting, to the cannibalistic proclivities of their own kind. Those that acquire wings rise in the air during the warmer parts of the day, and wend their way as far as the wind will permit toward their native home in the Northwest. They mostly carry with them the germs of disease or are parasitized, and wherever they settle do comparatively little damage.

DIRECTIONS IN WHICH THE YOUNG LOCUSTS TRAVEL.

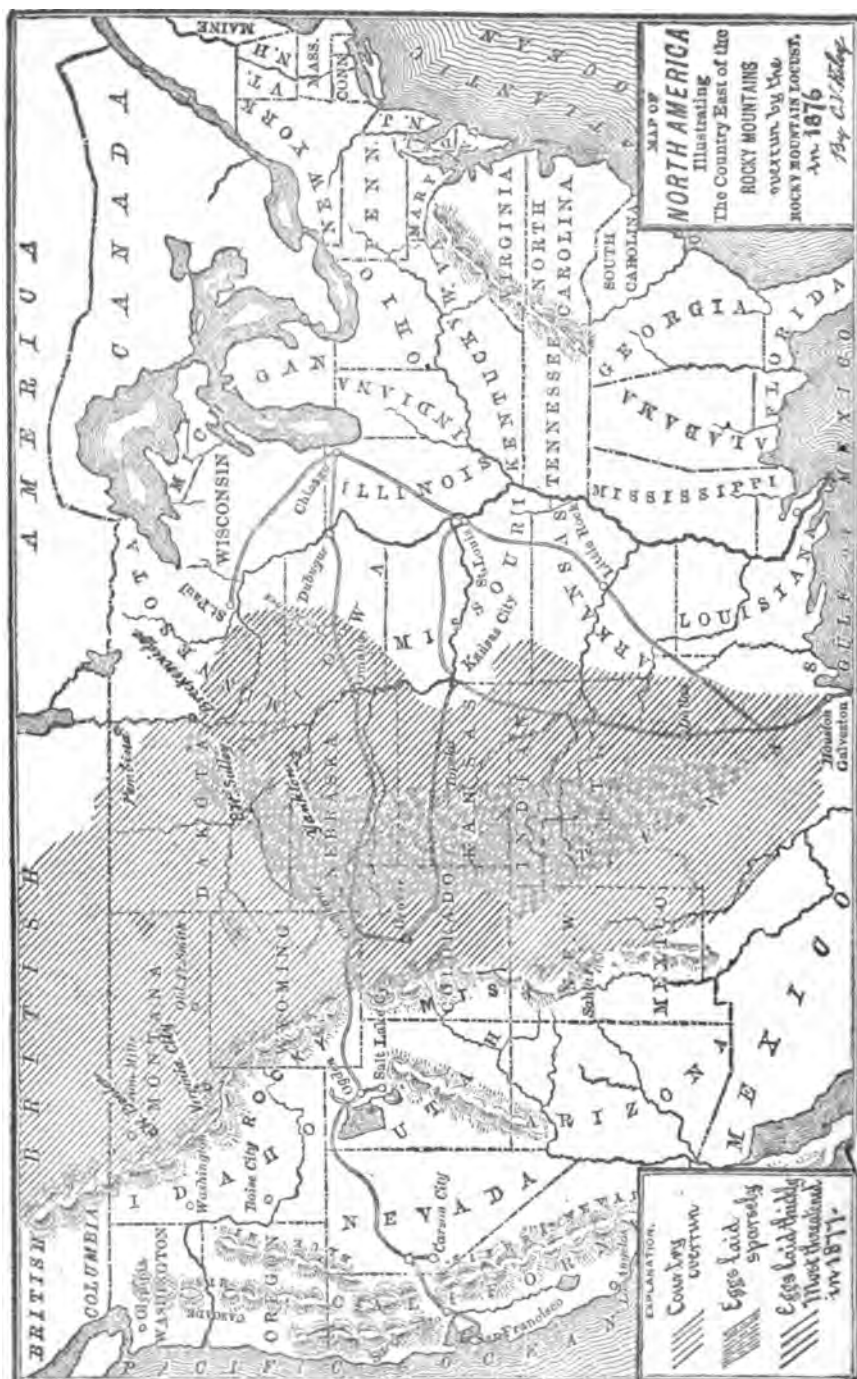
The young insects move, as a rule, during the warmer hours of the day only, feeding, if hungry, by the way, but generally marching in a given direction until toward evening. They travel in schools or armies, in no particular direction, but purely in search of food—the same school often pursuing a different course one day to that pursued the day previous. On this point the experience of 1875 is conclusive, though the bulk of the testimony as to their actions, when hatching out in States to the north and west, is to the effect that the prevailing direction taken is south or southeast, while in South Texas it is just opposite, or north. A person traveling along a road may often see them marching in one direction to the left and in the opposite direction to the right.

RATE AT WHICH THE YOUNG TRAVEL.

When about half grown they seldom move at a greater rate than three yards a minute, even when at their greatest speed over a tolerably smooth and level road, and not halting to feed. They walk three-fourths this distance and hop the rest. Two consecutive hops are seldom taken, and any individual one may be run down and fatigued by obliging it to hop ten or twelve times without a rest.

THEY REACH BUT A FEW MILES EAST OF WHERE THEY HATCH.

At the rate at which they travel, as just described, they could not extend many miles, even if they continued to travel in one direction from the time of hatching until maturity. They travel only during the hotter portions of the day, six hours on an average; and their unfledged existence terminates in from six to eight, say seven, weeks. It is very easy to calculate from these facts that if they continued in one direction from the time they hatch until they acquire wings, they could not extend thirty miles. In reality, however, they do not travel every day, and where food is abundant they scarcely travel at all. Moreover, as just shown, they do not commence traveling till after the first molt, and they do not go continually in a particularly eastern direction, but in all directions.

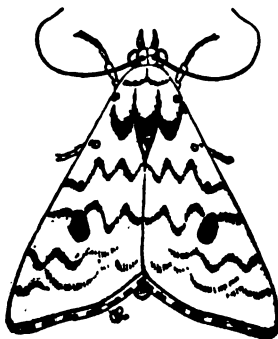


DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 3.

THE COTTON WORM.

SUMMARY OF ITS NATURAL HISTORY, WITH AN ACCOUNT OF
ITS ENEMIES, AND THE BEST MEANS OF CONTROLLING
IT; BEING A REPORT OF PROGRESS OF THE
WORK OF THE COMMISSION.



By CHAS. V. RILEY, M. A., Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

JANUARY 28, 1880.

C. V. RILEY, *Chief*,
Washington, D. C.

A. S. PACKARD, JR., *Secretary*,
Providence, R. I.

CYRUS THOMAS,
***Disbursing Agent*,**
Carbondale, Ill.

TABLE OF CONTENTS.

	Page
Introductory	1
Text of circular sent out by the Commission, 1—History of the investigation, 1—Need thereof, 2—Early work of Townend Glover, Thomas Affleck, and D. L. Phares, 2—Special report ordered by Congress, 3—Character of the Bulletin, 3—Division of the cotton belt into the southern or hibernating and the northern or non-hibernating portions, 4—Practical aim of the Commission, 4—Persons who have assisted, 4.	
1. Destructiveness of the Worm	7
LOSSES OCCASIONED BY IT	7
Increase of injury westward, 7—Least injury in northern portion of belt, 7—Tabular statement of loss for past 15 years, 8.	
2. Popular and scientific Names for the Insect	8
Most desirable popular name, 8—Different technical names by which the insect has been known, 8—Earliest description of it, 8.	
3. Characters and Stages of the Insect	9
THE EGG	9
The Worm always hatched from an egg, 9—Where the egg is laid, 9—Number of eggs to a leaf, 10—All eggs perish during winter, 10—Other eggs mistaken for those of Aletia, 10.	
THE WORM OR LARVA	10
Character of newly-hatched Worm, 10—Number of molts, 11—Variation in color, 11—Peculiar habits, 11—Flourishes on the cotton-plant only, 12.	
THE CHRYSALIS	12
Duration of chrysalis state, 13—It never transforms below ground, 13—How it may be distinguished from other species, 13.	
THE MOTH OR IMAGO	13
Distinguishing characters of the Moths, 14—Sexual differences, 14—Different habits at night and at day, 14—Fecundity, 15—It finds its natural food on the cotton-plant, 15—Fond of fruits, 15—Character of its tongue, 15.	
4. Time elapsing from one Generation to another	16
It varies greatly, but averages about one month, 16.	
5. Time of Year when the first Worms appear	16
Prevailing opinions erroneous, 16—The Worms hatch in April, 16—First Worms always in small numbers, 17—The third generation usually called the first, 17.	
6. Condition of Soil and Plant connected with the Appearance of the first Worms	18
The Worms appear first on low, moist, and rich lands, 18—Few exceptions to the rule, 18—The plant must be well advanced and luxuriant, 18—Some shelter generally near, 19—Reoccurrence year after year in the same spots, 19—Theory explaining first appearance under the circumstances observed, 19.	
7. Wet Weather favors the Development of the Worms	20
Humid and hot atmosphere most favorable, 20—Heavy storms destroy, 20—Effect of dryness, 21—Indirect influences of wet weather, 21—It prevents the working of the Worm's natural enemies, 21.	

	Page
8. Number of annual Generations	21
Prevailing general belief erroneous, 21 — Early generations often overlooked, 22 — Also often exterminated by natural enemies, 22 — At least seven annual generations in southern portion of belt, and probably more, 22.	
9. Migrations and Power of Flight of the Moth	21
The Moth has great power of wing, 23 — It flies many hundreds of miles north of cotton belt, 23 — Appearance of the Worm on cotton first planted great distances from any other cotton, thus accounted for, 23 — Migrating habit developed only in later moths when they become numerous, 24.	
10. Hibernation	24
Different opinions and beliefs, 24 — Difficulty surrounding the question, 24 — Erroneous conclusions easily drawn, 25 — Fallacy of the belief that the chrysalis winters underground, 25-26 — Ability of the Moth to survive the winter, 26 — Other Moths easily mistaken for it, 27 — Theory of annual introduction of the species from some exotic country, 28 — Arguments for and against the theory, 29-30 — Hibernation of the Moth in the southern portion of the belt substantiated, 30 — But a very small proportion of those which abound in the Fall live to perpetuate their kind the next spring, 31 — Localities where the Moth hibernates, 31.	
11. Natural Enemies	31
VERTEBRATES	33
Quadrupeds, birds, and reptiles that feed upon the Worm, 32 — Introduction of English sparrow, 33.	
INVERTEBRATES	33
<i>Predaceous Insects</i>	33
Wasps, Ants, and other Hymenoptera, 34 — The good work of Ants, 34 — How they are drawn to a cotton-field by the Aphides, 34 — Beetles which prey upon the Worm and others which presumably do so, 35 — Enemies among the Half-winged Bugs or Heteroptera, 36 — Among Two-winged Flies or Diptera, 36 — Among Nerve-winged Insects or Neuroptera, 37.	
<i>Parasites</i>	38
Previous belief that none preyed on Aletia, 38 — Infesting the egg, 38 — Infesting and issuing from the Worm, 39 — Flesh-flies and Tachina-flies, differences between them, 40-42 — Issuing from the chrysalis, 42 — A Parasite known but not named in 1852 — Ten distinct Parasites infesting Aletia, and two other undetermined species, 47.	
12. Remedies: Means of Coping with the Insect	47
Favorable showing as to what has been accomplished in the South since the war, 48.	
PREVENTION	48
Modes of cultivation, 48 — Topping, 48 — Use of early varieties, 48 — Isolating fields, 48 — Diversified agriculture, 49 — Rotation of crops, 49 — Protection of natural enemies, 49 — Early <i>vs.</i> late planting, 49 — Interpersing corn with cotton, 49 — Jute, 49.	
MECHANICAL MEANS OF KILLING THE WORMS	49
Simple methods of brushing and dragging, 50.	
<i>Machines for brushing off the Worms</i>	50
The Ewing brushing machine, 50 — The Helm brushing machine, 51 — The Wood-Smith brushing machine, 52 — The Iske brushing machine, 53 — Use of kerosene and coal oil with shallow pans or cloth frames, 54.	
POISONING THE WORMS	54
Impetus given to invention by the use of mineral poisons, 54 — Value of concerted action, 54 — General principles to be observed in poisoning, 55 — Dry <i>vs.</i> wet applications, 55 — Advantage in being prepared, 55.	

12. Remedies: Means of Coping with the Insect—Continued.

Page.

POISONING THE WORMS.—Continued.

<i>Arsenical Compounds</i>	55
Their value, 55—Safe and harmless where carefully used, 55—Caution necessary, 56—Antidote to arsenic poison, 56—Paris green, 56—When first recommended against the Cotton Worm, 56—Its value, advantages, and disadvantages, 56—Modes of using it, 57—Patents issued for Paris green mixtures, 57—They should be disregarded, 58—Arsenic, 58—It causes the squares to fall, 58—Patent granted for its use in 1871, 59—Johnson's Dead-shot, 59—Arsenate of soda, 59—Texas Cotton Worm destroyer, 60—Lodi pest poison, 60.	
<i>London Purple</i>	60
Its nature, and how produced, 60—Its efficacy as an insecticide, 60—Analysis of, 60—It proves a valuable poison for the worms, 61—Cheaper than Paris green, 62—Its persistency, 62.	
<i>Pyrethrum Powder</i>	62
Its origin and nature, 62—Its remarkable insecticide qualities, 62—Most effectual on the Cotton Worm, 63—Perfectly harmless to man, 63—The extract of the plant has the same virtue, 63—Growth of the plant in California, 63—Experiments conducted, 64—The alcoholic extract very potent, 64—Probable cost of using it, whether as powder or extract, 65—Highly encouraging prospects from its use, 65.	
<i>Kerosene Oil</i>	65
It causes instant death to the worm, but is difficult to apply without injuring the plant, 66—Vaporized by means of steam, 66—Used as a soap, 66.	
<i>Cotton-Seed Oil</i>	66
Acts much as kerosene, 66—Made into soap with ashes from hull of seed, 66—Might be profitably used around oil factories, 66.	
<i>Carbolic Acid</i>	67
As a means of keeping off the Moth, 67—Will not kill the Worm without injuring the plant, 67.	
<i>Sulphur</i>	67
<i>Extracts or Decoctions from various Plants</i>	67
<i>Yeast Ferment: Fungus infection</i>	68
Proposition by Dr. Hagen, 68—Dr. Bail's experiments, 68—Not in accord with leading mycologists, 68—Experiments with beer-mash, 69—With beer mash and east ferment, 70.	
<i>Machines and Contrivances for powdering</i>	74
Simple contrivance for mixing, 74—Ordinary method of applying dry poison, 75—Patented machines, 75—Hand duster, 75—The Willie duster, 75—The Hurd blower, 76—Combined duster and sprinkler, 78—The Davis duster, 78—The Levy duster, 79—The Taylor duster, 80—The Allen duster, 81—The Young duster, 81—The Goodheart duster, 81.	
<i>Machines and Contrivances for sprinkling and spraying</i>	81
Gracy's hand sprinkler, 81—The Ruggles sprinkler, 82—The Ramsey sprinkler, 82—The Taylor sprinkling apparatus, 83—The Townsend sprinkler, 83—The Willie sprinkler, 84—The Schanck sprinkler, 84—Peck's spray machine, 84—Fountain pump, 85—Machines for spraying on a large scale, 85—The Goodin sprinkler, 85—The Yeager sprinkler, 86—The Ruhmann sprinkler, 87—The Johnson spray machine, 88—The Warner saddle sprinkler, 90—The Binkley atomizer, 90—The Schier atomizer, 91—Ruhmann's improved atomizer, 93—The Daugherty atomizer, 94.	

	Page.
12. Remedies : Means of Coping with the Insect—Continued.	
POISONING THE WORMS.—Continued.	
<i>Machines for applying Vapors.</i>	
The Steinmann vaporizer, 97 — The Pearl vapor generator, 99.	
DESTRUCTION OF THE MOTH	
Results so far not encouraging, 100 — Action must be taken early in the season, 100.	
<i>Lamps for attracting the Moth</i>	100
Usually resorted to when too late to do practical good, 100 — Fires, 100 — Trouble of keeping them up throughout the night, 101 — Beneficial insects killed by lamps and fires, 101 — Advantage of lamps, 101 — The Garrett lamp, 101 — The Binkley lamp, 102 — The McQueen lamp, 103 — The Rigel lamp, 104 — The Walker lamp, 103 — Simple form of lamp, 104 — The Pugh lamp, 104 — Lamps in motion, 105 — Le Blanc's Cotton-Moth Destroyer, 105 — The Fordtran Cotton-Moth Destroyer, 105.	
<i>Poisoned Sweets and Fluids as Means of destroying the Moth</i>	106
Sweets attractive, 106 — Ripe fruits and melons often suffer, 106 — Baits that allure and kill, 106 — Experiments with them, 107 — Moths less attracted during summer than in autumn, 107 — Little inducement to use baits in autumn, 108 — They are most beneficial in spring, 108 — White rags, 108 — Theory of Dr. J. L. Lupton.	
Appendix	109
Answers to circular from West Feliciana Parish, Louisiana, 109 — From Evergreen, Ala., 111 — From Henderson, Tex., 113 — From Hempstead, Tex., 115 — Different views as to hibernation and mode of perpetuation of the insect, 116 — Answers to circular from Livingston, Ala., 117 — From parish of Concordia, La., 119 — From Natchitoches, La., 122 — From Jackson, Miss., 126 — From Larissa, Tex., 127 — From Perry Co., Ala., 128 — From Walterborough, S. C., 128 — From Jamestown, Fla., 130 — From San Antonio, Tex., 131 — From Kirkwood, Miss., 133 — From Woodville, Miss., 135.	

EXPLANATION TO PLATE 1.

Figs. 1, 1, 1. Eggs.

Fig. 2. Newly-hatched larva, or first stage

Fig. 2, a. Larvæ in second stage.

Figs. 2, b, b, b. Larvæ in third stage.

Figs. 2, c. Larvæ in third stage, suspended by silk.

Figs. 2, d, d. Larvæ in fourth stage.

Fig. 2, e. Larva in fifth stage.

Fig. 2, f. Larva in sixth or last stage, and full grown; side view and pale form.

Fig. 2, g. Larva full grown; side view; dark form.

Fig. 2, h. Larva full grown; back view.

Fig. 2, i. Larva in fifth stage, in act of springing.

Fig. 3. Chrysalis just changed and freed of its cocoon.

Fig. 3, a. Chrysalis partially covered and ready to give forth the moth.

Fig. 3, b. Cocoon entirely surrounding chrysalis.

Fig. 4. Female moth with wings expanded.

Fig. 4, a. Female moth with wings closed; back view.

Fig. 4, b. Male moth with wings closed; side view.

Figs. 5, 5, 5. Membranous patches of leaf, showing how the parenchyma is eaten by young worms.



[illegible]



V. Riley del et pinx.

THE COTTON WORM
(*Aletia argillacea*)

Digitized by

Google

Library of the U. S. Department of Agriculture

INTRODUCTORY.

The following text of a circular, distributed last summer in the cotton-growing States, will help to an introduction to this bulletin:

[Circular No. 7.]

RELATING TO THE COTTON WORM.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE U. S. ENTOMOLOGICAL COMMISSION,
_____, 18—.

Mr. ———:

DEAR SIR: The undersigned has for many years keenly felt that there was great need of more accurate knowledge of the habits of the Cotton Worm (*Aletia argillacea*) and of the other insects injuriously affecting the cotton plant, as also of more satisfactory means of counteracting their injuries. Recognizing the vast importance of the subject to the people of the South, one of his first efforts, after accepting the position of entomologist to the Department of Agriculture, in May, 1878, was to commence a special investigation looking to those ends.

An appropriation to the Department was obtained for the purpose, and the investigation was carried on under his direction up to the time of his resignation, on the first of May last. Since that time Congress has required the United States Entomological Commission to continue the work, and said Commission, at a late meeting, decided to place this part of its work in his charge. On behalf of the Commission he would, therefore, call the attention of correspondents to the following questions and topics, with the request that answers thereto, or experience thereon, be returned to him some time before October next.

Some correspondents whom this circular will reach may already have answered a more detailed one, sent out last year by the writer while connected with the Department of Agriculture. He would beg such to again give their experience on the fewer topics of the present circular.

He will be glad to receive figures, either photographs or drawings, of machines or contrivances employed for the wholesale use of the Paris-green mixture, either in the fluid state or as a powder; or any other kinds of machines or traps employed for the destruction of the insect. Models of such are still more desirable, and may be sent by express, unpaid, to the headquarters of the Commission. Correspondence is solicited whenever any expense must attend the carrying out of these requests, in order that authority may be given to make the necessary outlay and thus insure the refunding of the amount.

Respectfully,

CHAS. V. RILEY,
Chief U. S. E. C.

1. During what year was cotton first grown in your State, county, or locality?
2. How many years elapsed after cotton first began to be grown before the worm began to work upon it?

3. Is the worm most dreaded after a mild or after a severe winter?
4. Do wet or dry summers favor its multiplication?
5. What is the earliest date at which you have known the worm to appear in spring?
6. In what locations does it most often first appear?
7. What is your experience, and what are your views, as to the winter habits of the insect?
8. What natural enemies of the worm among birds, quadrupeds, or insects are you familiar with?
9. What has been the result of the efforts to allure and destroy the moths, and what methods have proved most satisfactory? Give your estimate of the relative value for this purpose of poisoned sugar, molasses, and vinegar, or other poisonous substances, and fires.
10. Are the moths most attracted to sweetened substances when smeared upon trees, boards, &c., or when contained in vessels in or near which lamps may be lighted?
11. Are any flowers known to be attractive to the moth? If so, specify them and their season of blooming.
12. What do you know, from your own observation, of the influence of jute grown near or with the cotton?
13. Has anything been found more generally useful and applicable, or cheaper, than the use of the Paris-green mixture, or of arsenic in some form, to destroy the worms?
14. Have you known of any injurious effects following the use of this poison, either to the plant, to man, or to animals?
15. State what you consider the best and most effective method of destroying the worms in your section.
16. State the cost per acre of protecting a crop by the best means employed.

Correspondents will confer a favor by numbering the replies to correspond with the questions, and by writing on but one side of the paper.

The need of such an investigation, and even of a much more thorough one than the limited means so far appropriated therefor by Congress have permitted, is, I venture to believe, made apparent from the following pages. Mr. Townend Glover, during his earlier connection, as entomologist, with the Patent Office and the Department of Agriculture, gave much time to the study of the insects affecting cotton, and published in the Agricultural Reports for 1854 and 1855 much valuable information there anent, which has been a text for most subsequent writings on the subject. The science of entomology was then in its infancy in this country, and Mr. Glover labored under many difficulties in the proper determination of species and in other ways, which necessarily prevented that scientific accuracy and thoroughness which is desirable. Yet to his labors and those of a few Southern men like the late Thomas Affleck, of Brenham, Tex., and Dr. D. L. Phares, of Woodville, Miss., we owe all that was known and in any way reliable on the subject up to within the present decade; while his copper-plate figures of the principal insects affecting the plant, of which figures he published in 1878 a limited number of copies for distribution at his own expense, are so admirable and instructive that it is cause for regret that they were not long since issued, with appropriate text, by the Department of which he was so long the entomologist.

It may safely be said that up to 1878 scarcely any facts had been added, by direct observation, to those which Professor Glover had published regarding the Cotton Worm twenty-five years ago.

During my direction of the investigation under the Department of Agriculture many interesting, chronological, statistical, and biological facts were obtained on the subject of the Cotton Worm. As one of my last efforts while yet connected with said Department was to get the printing of 10,000 copies of a special report on the subject ordered by Congress, it will devolve on my successor, Prof. J. H. Comstock, to prepare the material thus collected for publication. Professor Comstock was one of the special agents whom I had engaged to assist me, and did most satisfactory work; he is, therefore, well qualified for the labor that has fallen upon him. Most of the more practical questions, however, as well as those which necessarily required more extended research than could be encompassed in a single year, were left for future solution, and it is to these that, on the part of the United States Entomological Commission, I have been primarily devoting my attention the past summer.

This bulletin is a brief summary of results thus far obtained and is issued as a prodrome of the final, more exhaustive report which the Commission hopes to be able to make. It will serve, also, as an indication both of what has been accomplished and of what is yet to be accomplished; for few persons have any idea of the amount of time and labor required to obtain positive, final and satisfactory results in the many paths that lead from an investigation of this kind.

The text has for the most part been prepared in the intervals of active field-work, and most of the classified details and experiences upon which the statements and conclusions rest, are reserved for the final report. By this course the preparation and printing of the bulletin have been expedited, and it has been kept within due bounds as to size. For the same reasons none of the other many insects affecting cotton are treated of, though a great deal of information respecting them has been collected for our final report.

In order to treat exhaustively of several of the more important questions, it becomes necessary to study the history of cotton culture in all other countries as well as in the United States, and also to more definitely classify the cotton regions of the latter. In its first report on the Rocky Mountain locust the Commission found it convenient and even necessary to divide the country over which that insect occurred, into three regions, representing, respectively: 1st, The permanent breeding-grounds where the species is always found. 2d, The subpermanent region to which it frequently spreads, but from which it may be absent; and, 3d, The temporary region which it visits at irregular intervals, and in which, as a rule, it dwells but a single year at a time. These divisions have a *raison d'être* in the facts observed, but we recognize that, like all classificatory divisions, they are more or less arbitrary.

Some similar classification of the cotton belt will also greatly aid in the treatment of this Cotton Worm question, and as a temporary classification, to be elaborated in future, I have divided said belt into, 1st, the southern or permanent portion, where the first worms annually

appear and the moths in all probability hibernate; 2d, the northern or temporary portion, in which the insect does not hibernate, but into which it spreads, either by gradual dispersion or by more sudden migration, from the permanent portion. The dividing line between these two portions must needs be difficult to define, because there is an uncertain region that may, according to season or circumstance, belong to either, and also because of the limited observations that have yet been made. Taking the early appearance of the worms as a basis, the southern portion may be thus roughly defined: Beginning with Texas, it includes the region south of the Galveston, Harrisburg and San Antonio Railroad, excluding perhaps the extreme western portion, but extending somewhat farther north along the river bottoms. In Louisiana and Mississippi it includes the valley of the Mississippi River and its tributaries, with uncertain northern limits. In Alabama it is represented by the limestone cotton belt south of Montgomery, though probably extending farther north to the east of that point. In Georgia it does not extend north of Albany on the west, but doubtless includes the sea islands along the coast, as also those of South Carolina, though at the present time cotton cultivation is limited to Saint Catharine's Island. In Florida it includes all parts where cotton is grown.

The facts given in this bulletin are, many of them, for the first time published. If they oppose previously accepted views and opinions, they at the same time dispel many errors that have heretofore prevailed as to some of the more important questions in the natural history of the species. The pamphlet is prepared for the benefit of the planter and popular reader, with as little of the technicality of science as is consistent with clearness and precision, and with such matter as more particularly interests the scientific reader printed in smaller type.

The principal aim of the Commission has been to discover some sater and cheaper remedy than any previously in use. Its efforts in this direction have been limited by the means at command; yet, as the context will show, they have resulted in materially cheapening the cost of protecting the crop, and there is promise of still greater improvement.

The Commission has had the aid and co-operation, in this southern part of its work, of a number of correspondents; but its acknowledgments are especially due to Mr. E. A. Schwarz, of Detroit, Mich., who has acted as special agent in South Texas, where he remained from the beginning of May till the middle of September; also to Prof. E. A. Smith, of the University of Alabama, at Tuscaloosa; Prof. J. E. Willet, of Mercer College, at Macon, Ga.; Dr. E. H. Anderson, of Kirkwood, Miss.; Judge J. F. Bailey, of Marion, Ala.; Mr. W. H. Patton, of Waterbury, Conn.; Mr. W. A. Henry, of Ithaca, N. Y.; and General A. C. Jones, of Washington, D. C. My acknowledgments are also due to Professor Comstock, Prof. A. R. Grote, of Buffalo, and Judge J. W. Jones, of Virginia Point, Tex., for co-operation while I was yet connected with the Department of Agriculture. My own field labors during the

year have covered all the cotton-growing States, except Florida and South Carolina.

The figures when enlarged generally have the natural size indicated in hair-line, and the Messrs. Hoen & Co., of Baltimore, deserve credit for the faithful manner in which they have reproduced the colored plate by their admirable lithocaustic process.

Appreciating the value of cumulative experience from all parts of the cotton belt, and on all points where experience may differ, I would respectfully solicit correspondence from all who may find interest in these pages, and who have facts to communicate.

C. V. R.

WASHINGTON, D. C., *November 3, 1879.*

THE COTTON WORM.

(*ALETIA ARGILLACEA* Hübn.)

1. DESTRUCTIVENESS OF THE WORM.

LOSSES OCCASIONED BY IT.

An impartial calculation of the money loss to the cultivator caused by injury to the great staples of the country from their insect enemies, is sure to startle us by its magnitude when the loss is aggregated. Such a calculation of the losses which the Cotton Worm (not to speak of other insects) inflicts on the people of the South, based upon the somewhat imperfect statistical data at command, leads to the following interesting conclusions, which for the most part receive explanation in the facts embodied in this bulletin. The calculation embraces the fifteen years since the close of the civil war, and was made by Mr. C. R. Dodge, and verified for me by Mr. J. R. Dodge, the statistician. Any extraneous causes which tend to retard the growth of the plant, also tend to swell the percentage of injury by the worm when it abounds. Where an early stand is secured, with thorough cultivation and exemption from other causes of injury, there the percentage of loss is least, even in bad Cotton Worm years. The percentage of loss is, also, dependent on location. When the injury is done early in the season, the loss in localities of heaviest production, or where the fields are numerous and contiguous, is nearly double what it is where the fields are more isolated. In years of severe injury, from 30 to 98 per cent. of the crop may be ruined upon some plantations, while on others the loss will be trifling. The highest average of loss is sustained in the southern portion of the belt, as in Florida and southern Texas. It increases also in a westerly direction, commencing with Georgia at 16 per cent., or 16 bales out of every 100 of an average crop for fifteen years, and ending with Texas at 28 per cent. In the northern portion of the belt the averages are low, ranging from 5 to 8 per cent. for the same period; while in many parts of it, and notably in North Carolina, the worm appears so late as to generally do more good than harm by removing the luxuriant top foliage, and thus admitting the sun to the lower bolls and hastening their maturity.

The following table shows the amount of loss in bales and dollars for each State in a year of severe visitation.

State.	Per cent. of loss.			Crop.	Losses.	Money loss
	Highest.	Lowest.	Average for State.	Average number of bales for 15 years.	Average number of bales for worst years.	For worst years at \$50 per bale.
Florida.....	.....	.....	24	49,700	12,000	\$600,000
Georgia.....	25.1	15	18.6	474,000	78,422	3,912,000
Alabama.....	25.2	12.5	17.8	536,700	95,790	4,789,000
Mississippi.....	24	15	17	706,000	123,070	6,150,000
Louisiana.....	.....	.....	20	438,000	89,740	4,437,000
Texas.....	35	20	28	525,000	148,125	7,406,000
South Carolina.....	.....	.....	05	224,500	11,225	560,000
Tennessee.....	.....	.....	05	147,000	8,365	418,000
Arkansas.....	.....	.....	08	347,000	27,760	1,380,000
North Carolina.....	.....	.....	.....	.....	.....	.....
Totals.....	.....	.....	15.5	3,449,200	504,497	29,711,000

This table shows a possible loss of about \$30,000,000 in years of general prevalence of the worm, or an average of 15½ per cent. total annual loss, viz., \$12,934,500, for all the cotton States since the war. That it was equally great before the war there is no reason to doubt, for while severe visitations have, perhaps, been more frequent since that time the injury has been greatly diminished by the use of Paris green and other arsenical poisons since the year 1873.

2. POPULAR AND SCIENTIFIC NAMES FOR THE INSECT.

Among planters the worm is very often termed the "Caterpillar," or the "Cotton Caterpillar," and not infrequently the "Army Worm." I have elsewhere shown* why this last term should be discountenanced in the literature of the subject, unless prefixed by the word "Cotton," and both for the sake of brevity and to prevent confusion the name used in this bulletin, and by which the insect in this larva state is very generally known, is, on the whole, preferable. In Louisiana, more particularly, the French term "Chenille," meaning caterpillar, is commonly employed. For the perfect insect the term "fly" is more often used in some parts of the South than the term "moth," but the latter is preferable from an entomological view.

As to the scientific name, the species was first described by Thomas Say, in 1827, as *Noctua xyliua*, in a letter to Dr. C. W. Capers, published in the *Southern Agriculturist* (vol. I, p. 203), but overlooked by most later writers. Harris, in his Correspondence, placed the "Cotton Moth" near the genus *Ophiusa*, while later authors more correctly referred it to Hübner's genus *Anomis*. Mr. A. R. Grote first gave a correct synonymy of the species in 1874,† and pointed out that Hübner

*Second Mo. Ent. Rep., p. 37.

†Proc. Am. Ass. Adv. Sci., 1874, B., p. 18.

had figured and referred to it in 1822 by the appropriate name of *Aletia argillacea* here employed. The differences between *Anomis* and *Aletia* are slight, but by accepting them as of generic value, our Cotton Moth becomes the only species of its genus in the United States, and there is no reason why the word "*Aletia*" should not come into general and popular use to designate the species in all its stages, just as so many other scientific terms for familiar plants and animals have been, by example, added to the common language. Some such short simple term is so desirable in popular reference to the insect that it is frequently used in this bulletin in the hope of its being adopted.

3. CHARACTERS AND STAGES OF THE INSECT.

The Cotton Worm, like most other insects, and all belonging to its Order and Family, exists in four distinct states, which differ much from each other. They are, 1st, the *egg*; 2d, the *larva* or worm; 3d, the *chrysalis*; 4th, the *imago* or moth.

The worm **MUST** hatch from an egg deposited by the female moth. All theories to the contrary, such as its supposed spontaneous development from the plant, or its origin from the cotton-seed, are therefore utterly without foundation. They need emphatic denial here, because of their prevalence not only among the negroes and the more ignorant, but among intelligent men unfamiliar with the principles of biology. Such theories always have been, and doubtless always will be, entertained in explanation of the apparently sudden appearance and rapid multiplication of any insect or other organism in which the preliminary phases of the phenomena are easily overlooked or with difficulty traced. Reserving minute descriptive details for future report, I will briefly indicate the characteristics of these four states, so as to enable the reader unacquainted with any or all of them to recognize the species in any phase of its growth and to distinguish it from all other insects. On the plate, more particularly, I have represented, of natural size, all the different phases, as they may be observed in the field.

THE EGG.

The egg is 0.6^{mm} wide, circular, much flattened and ribbed, as at Fig. 1. Of a bright bluish-green or sea-green when first laid, it contrasts sufficiently with the warmer green of the leaf to be easily detected, even by the naked eye when practiced (Plate I, Figs. 1, 1). It is laid singly, and fastened with such firmness as not to be easily removed without injury. It is laid by preference during early summer on the under side of the larger and lower leaves, and seldom more than three or four are found on one leaf. In con-

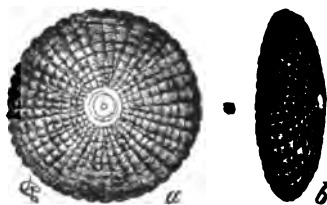


FIG. 1.—EGG OF ALETIA: a, from above; b, from side. (After Riley.)

finement and exceptionally in nature it will be laid on the upper surface of the leaf, or on any other exposed part of the plant. In autumn, more particularly, the upper leaves receive a due share of the eggs, and I have counted as many as 49 eggs and egg-shells on a single leaf. With development the color becomes more dingy, or pale yellowish, frequently with brownish borders or a green curve, due to the coiled embryo, which may be seen through the transparent shell. The young worm or larva eats its way out through an irregular hole on one side, usually during the morning, ere the dew is dissipated, and from three to four days after oviposition. This is the average time elapsing between the laying of the egg and the hatching of the worm therefrom in ordinary midsummer weather, but the time varies with the temperature, and a much longer period is required in spring and late autumn.

All eggs perish that are unhatched when overtaken by frost, as is not infrequently the case. The vacated and glistening shell is more readily noticed upon the green background than the unhatched egg. At Fig. 1 I have shown one of the more perfect eggs both from above (a) and from the side (b), and greatly enlarged, so as to indicate the sculpture, the natural size being indicated between them.

Humidity seems to favor hatching. Aphides or plant-lice are quite often mistaken for the eggs of this insect, while the "Mealy bug" (*Dactylopius adonidum*), a species of *Aleurodes*, the eggs of the lady-birds (*Coccinellidæ*), those of the Lace-wings (*Chrysopa*), and even a minute snail, not uncommon on the cotton plant, are likewise so mistaken.

THE WORM OR LARVA.

This, as it appears in its different stages of growth on the colored plate, is familiar to every planter. Varying greatly in ground-color, it is characterized by the particular position of the black piliferous spots upon the head and upon the body; by the white ring which surrounds each of the latter; by its pure white subdorsal lines and by its elongate and slender form. It is a semi-looper, the first pair of prolegs being very much reduced in size and seldom used, and the second pair, though longer, only about half as long as the succeeding pair.*

The worm molts five times during growth and changes appearance but little after the first molt. Exceptionally only four molts are suffered.

The newly-hatched worm measures 1.6 mm, is of a uniform pale dingy yellow, marked as in Fig. 2, with polished black, slightly elevated spots, each bearing a short pale hair. Before the first skin is shed the color often be-

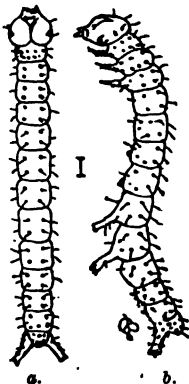


FIG. 2.—NEWLY-HATCHED COTTON WORM: a back; b side view. (After Riley.)

*In alcoholic specimens the first pair often appear as mere tubercles without clasping hooks, but these really exist, though withdrawn from sight. The legs are perfect, therefore, and simply atrophied. In this respect the larva of *Aletia argillacea* differs from that of another species (apparently *Anomis exacta* Hübn.), which occurs in South Texas, for in this last species the claspers are wanting and the legs really obsolete and replaced by mere tubercles. Otherwise the resemblance between the two larvae is such as to cause them to be easily confounded.

comes slightly greenish and sometimes inclines to orange. After the first molt the piliferous spots are more conspicuous, the hairs from them longer and black and the characteristic markings appear, though less distinctly than after the second; but from this time on the prevailing color is very variable, being either entirely of various shades of pale or pea green, or more or less intensely black along the back.

The normal number of larval molts is five. This is the number which I have observed during the autumn months, while in midsummer, when the development is more rapid, I have on several occasions traced but four. The term of larval existence varies from one to three weeks.

There is a very general belief among planters that the first worms of the season are pale and the late ones dark, and while both light and dark worms may always be found together in spring, summer, or fall, it is true that the green ones predominate early in the season and the dark ones later.*

Immediately after molting, the body is pale and without marking—a rule with all molting animals. After the earlier molts, the cast-off skin, which remains more or less fully stretched, is sometimes eaten.

Some of the peculiarities in the habits of the worm deserve mention here because of their practical bearing.

Until after the second molt it always remains on the under side of the leaf, feeding upon the parenchyma, and leaving untouched the coarser veins, stomata, and upper skin or epidermis. The leaves where they are thus feeding present a blotched appearance, the semi-transparent epidermis becoming pale yellowish, and these blotches are, as a rule, at once distinguishable from other somewhat similar ones made by a few other insects.†

After the worm begins to eat entirely through the leaf, which is usu-

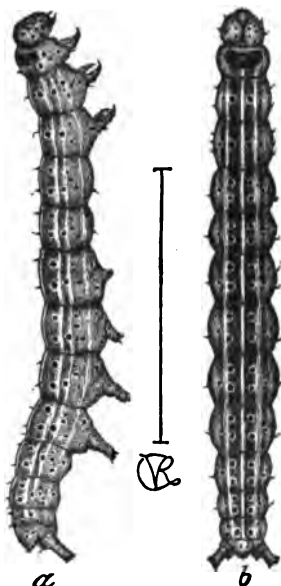


FIG. 3.—FULL-GROWN COTTON WORM: a from side; b from back; twice natural size. (After Riley.)

* The larva of *Plusia dyauis* Grote is not uncommon in spring and early summer on cotton. Being a semi-looper and bearing in color and mode of pupation a general resemblance to the *Aletia* larva, it is often mistaken therefor by planters. It is invariably pale green, without dark shades, and may have helped to the popular belief in the first worms being green. But while I have invariably found dark individuals among the earliest and throughout the summer generations, I was struck during a trip made last October through Mississippi, Alabama, and Georgia by their great preponderance, the intensity of the black (often obliterating the white annuli and subdorsal stripes), and the early stage of growth (often after the first molt and very generally after the second) in which it appeared. In the spring and early summer the black is more often confined to the fifth and sixth stages.

† The young larva of *Spilosoma aceræ* makes somewhat similar but larger blotches.

ally before the third molt, but sometimes later, it instinctively ascends toward the top of the plant and feeds on the more tender foliage, "ragging" it, to use the expressive language of the planter.

It can let itself down by a web from the moment of birth, but can also fling itself from one part of the plant to another in a manner quite characteristic. The fling or jump is made by bending the fore and raised part of the body to one side and then suddenly jerking it to the opposite side, relaxing meanwhile the three hind pairs of legs by which it held to the plant. This is a quite common mode of motion when disturbed, and the normal way of getting from one plant to another. The maximum distance which a worm can thus jump in a horizontal direction is about two feet, and it almost invariably alights on its legs. During chilly weather in autumn this motion is feeble and can be easily watched. When not feeding, the worm either rests stretched straight on some part of the plant or may be seen swaying its fore body from side to side, holding the while by the hind prolegs.

Though preferring the foliage, it will, when hard pushed, eat every exposed part of the plant, even barking and girdling the stems. In feeding on the bolls, however, it does not bore like the Boll Worm (*Heliothis armigera*), but eats the external parts as well as their contents. It cannot thrive on any other plant than cotton, and is evidently confined in its diet to the different species of the particular genus *Gossypium*. At all events there is yet no satisfactory evidence to the contrary, all experiments made confirming the belief.*

As one correspondent naively puts it, "the worms feed only on cotton and one another," the cannibalistic propensity being freely indulged when the occasion presents. It is a common remark that the presence of the worm is easier detected by smell than by sight. The planter says that he can "smell the worm." There is a peculiar odor arising from the excrement, but particularly from the gnawed and mutilated leaves that gives rise to this saying; but where the worms are numerous and large enough to render it obvious, there they have already existed several days, perhaps weeks, in smaller numbers.

When numerous enough to utterly defoliate a field before they have attained full growth, the worms will travel in all directions on the ground, and they have been exceptionally known to collect together and travel in vast bodies in their search for fresh food.

THE CHRYSALIS.

Having obtained full growth, the worm, in the language of the planter, "webs up," forming for protection a more or less perfect cocoon, usually

* Mr. Schwarz succeeded in feeding one from the hatching period till it transformed to chrysalis on a species of Morning-glory (*Ipomea commutata* Roem & Sch.), but the chrysalis was imperfect, and finally perished. I find that quite a number of persons believe that the worm feeds on Abutilon and Pokeweed (*Phytolacca*), but the belief rests solely on the fact that these plants are often defoliated when the Cotton Worm is stripping the cotton fields. In the case of *Phytolacca*, as Professor Willet has been able to prove, it is an entirely different worm which does the work, and the same is doubtless true of the Abutilon. Mr. Phillip Winfree, of Mulberry Creek, La. (De Bow's Ind. Res. of S. & S.W., 1852, p. 173), remarks that it feeds in the West Indies on a plant called the salve bush, resembling somewhat the common Mullein.

within the fold or roll of a leaf, sparsely lined with silken meshes. Here it contracts and thickens, the distinctive marks are nearly obliterated, and the green color acquires a verdigris hue. Within twenty-four hours, in midsummer, the skin splits just back of the head, and is gradually worked to the end of the forming chrysalis, now soft and green, but acquiring in the course of an hour or more a brown color and firmer consistence. This chrysalis state lasts, on an average, about a week in hot weather, but may extend to thrice that time with lower temperature.

Where necessity obliges, the worm will spin up on any other plant or in any situation that offers shelter. In confinement it will make a cocoon on the surface of the ground, covering and disguising the same with particles of earth, or it will even transform on the ground without silk or shelter. Such

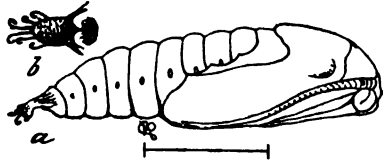


FIG. 4.—CHRYSALIS OF *ALETIA*: enlarged to show cremaster from the side (a) and from beneath (b). (After Riley.)

cases rarely if ever occur in a state of nature, but when the worms are very numerous in a field the chrysalides frequently have their leafy protection eaten away, so that many of them either hang by the few hooks at the extremity, or fall to the ground. In no case, however, does the worm burrow in the ground as does the Boll Worm, or could the moth issue from the chrysalis were the latter accidentally buried even an inch beneath the surface.

We shall presently see, in discussing the hibernation of the species, that it is quite important to distinguish between this chrysalis and others that closely resemble it, and to enable the reader to more readily do so an enlarged outline is here introduced. The color varies from light mahogany-brown to deep purplish-brown, while the general form is that belonging to many other chrysalides. Neither form nor color can serve then as distinguishing traits, and the same is true of size. The peculiar form of the cremaster, or anal tubercle bearing the hooklets (Fig. 4), will prove the best and safest criterion, and any chrysalis found in a cotton field that has a different tip may be safely determined as not that of the Cotton Worm. The duration of the chrysalis state also averages about fifteen days. I have known it to last but seven days, and Mr. Glover records its lasting thirty days.*

THE MOTH, OR IMAGO.

The moth measures from $1\frac{1}{2}$ to $1\frac{1}{2}$ inches from tip to tip of wing when these are expanded. Its general color, above, is olivaceous, more or less effectually subdued by lilaceous or purple hues, and often having a clay-yellow, or faintly golden cast. The under side is more gray, with nacreous reflections.

The markings that more particularly characterize and distinguish it from all other North American moths are certain undulating vinous or

* Report Department Agriculture, 1856, p. 73.

carmine lines across the front wings, a dark oval spot near their disc containing pale scales, which usually form a double pupil (the basal or inner one the smallest and whitest), and *three white specks dividing the space between this dark spot and the shoulder in about three equal parts.* (Fig. 5, *a a a*.)

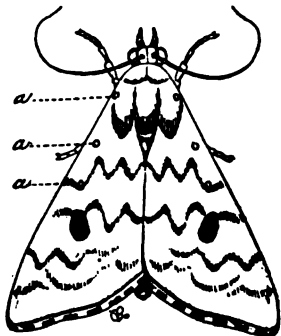


FIG. 5.—OUTLINE OF ALETIA: showing characteristic marks and white specks (*a a a*)—twice natural size. (After Riley.)

The sexes are not readily distinguishable, as the relative stoutness of the male antennæ compared with those of the female is so slight as to be no safe guide. An examination of the tip of the abdomen, especially from the side, will always show the difference, however, the last joint in the male (Fig. 6, *a*) being the longer and more full, and the pale tufts of hair that belong to the withdrawn genitalia* showing within or beyond the squarely docked tip; while in the female (Fig. 6, *b*) this joint is shorter, more pointed, and obliquely truncate beneath.

The habits of this moth can only be studied at night, as, like almost all the rest of its family, it is nocturnal. During the day it simply starts up when disturbed, and darts by swift and low flight to some other sheltered spot a few yards, or perhaps rods, away. After sunset, however, it may be seen leisurely hovering about, either bent on the perpetuation of its kind or feeding upon whatever sweets it can get, whether from the cotton or from other sources. It is very strong and swift of wing, and capable, when the necessity arises, of flying long distances. In alighting upon the plant it generally turns its head downward, and when it rests, the wings are but shallowly roofed, the front ones closed along the back and fully hiding the hind ones. In this respect it may always be distinguished from the parent of the Boll Worm, which rests with the front wings partly open and not entirely covering the hind ones.

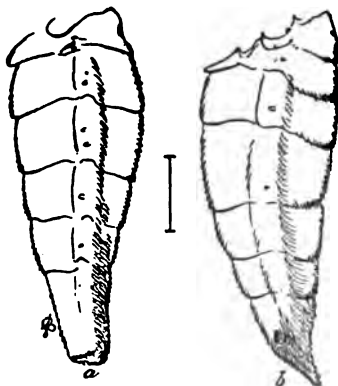


FIG. 6.—COTTON MOTH: *a*, male abdomen; *b*, female do.—enlarged. (After Riley.)

The female begins to lay her eggs in from two to four days after issuing from the chrysalis, the time varying with the different generations and according to temperature.

In experiments which I have made with moths confined in vivaria,

*The male genitalia in this species are remarkable for having two extensile organs, usually retracted and showing as dense tufts of hair, but capable of extension to thrice the length of the rest of the armature; also for two attenuated double-jointed spines which lie when at rest in a sheath on one side of the penis with the points extending beyond it, but which in action bend back at right angles therefrom.

eggs have sometimes been laid thirty-six hours after issuing, and the moths have continued laying for twenty-one nights, the number laid each night ranging from 4 to 45.

Examination of the ovaries of females at different seasons shows a much greater prolificacy than belongs to most moths, as the number of well-developed ova may reach 500, and of potential ova half as many more. In confinement it is difficult to obtain from one female more than 300 eggs, but that fully double this number are produced in the field during the height of the season there can be little doubt, while the average number may be estimated at about 400.

The natural food of the moth, as first shown by me in the fall of 1878,* is the sweet exudation from the glands upon the mid-rib of the leaf and at the base of each lobe of the involucre of the cotton plant. Nevertheless it is attracted to all kinds of sweets, and in most parts of the South it finds a bountiful supply in the exudation from the spikes



FIG. 7.—COTTON MOTH: a, with wings expanded; b, with wings closed. (After Riley.)

of *Paspalum lœve*, a tolerably common grass, but particularly in that copiously secreted by glands at the apex of the peduncle, just above the pods of the Cow-pea (*Dolichos*). In the spring of the year, as Judge Bailey, of Marion, Ala., has observed, it may often be seen in the evening feeding in numbers, first from the blossoms of the Chicaw plum, and subsequently from those of the peach, Chinese quince, mock orange (*Uerasus Carolinensis*), the early apples, and blackthorn. Later in the season, when the glands above mentioned begin to exude and the tree blossoms are no more, the moths do not seem to be attracted by other nectar-storing flowers, since observations during the past two years by myself and assistants have resulted in finding but one species of verbena (*Verbena aubletia* L.) frequented, even where both moths and all sorts of flowers were abundant. But fruits of all kinds as they ripen are resorted to, and figs, apples, peaches, plums, apricots, grapes, persimmons, and even melons are often greatly injured.

Carefully examined, the tongue is seen to be armed along its terminal half with stout and sharp spines projecting forward from the upper surface and increasing in density toward the tip, which is beset with them on all sides. It is by means of this spinous tip of the tongue that the moth works a hole in these fruits, and is thus enabled to absorb the more liquid portions. Apple pomace is especially attractive to them.

*See *Atlanta (Ga.) Constitution*, September 20, and *Scientific American*, November 15, 1878.

4. TIME ELAPSING FROM ONE GENERATION TO ANOTHER.

This varies according to temperature, and therefore according to season. There is increasing activity and acceleration in development from the first appearance till July, and thenceforth decreasing activity and retardation in development till frost. Thus in midsummer the whole cycle of individual life, from the hatching to procreation, may occupy less than three weeks; while in spring and late autumn it may occupy twice that time. Taking the whole season through, however, the time from the egg of one generation to that of another will average about one month.

5. TIME OF YEAR WHEN THE FIRST WORMS APPEAR.

Until the investigation, of which this is only a preliminary report, was begun, our knowledge as to the earliest appearance of the worms was not only vague, but misleading. The statement emphasized by Professor Grote in the paper already referred to, namely, that the worm does not appear earlier than the latter part of June in the central portion of the cotton belt of Alabama and Georgia, very fairly echoes the prevailing popular belief on the subject; yet careful investigation the present season, and the collection of facts recorded in past years, show the statement to be essentially erroneous. The date of earliest appearance varies with location, and largely with the curves of isochimal lines;* it also differs somewhat in different years in the same location, according as the season may be late or early; and, lastly, it may differ to some extent in different parts of the same restricted locality, worms having been found just hatching in one place when, only a few miles distant, others were found nearly full grown.

While these modifying circumstances complicate consideration of the subject, it is easy to arrive at definite results by taking as a basis observations made at a few particular points during the present year. Hence I felt the importance of having such observations made the past spring in South Texas and South Alabama at those places where the worm was reported to have appeared earliest in past years. As a result, the fact is fully established that the first worms of the season may, and do, in ordinary years, hatch from the middle of April to the middle of May in the southern portion of the cotton belt. Indeed, it was this year observed so much earlier in Alabama than was formerly reputed that many journals announced the fact as very exceptional. Yet there are no good reasons to suppose the present year exceptional or abnormal in

* This is well illustrated by a fact communicated by Dr. D. L. Phares, of Woodville, Miss., viz, that the worm usually begins its work of destruction in Madison County from three to six weeks earlier than in Wilkinson; the former on latitude 33° and the latter resting on 31°. At Madison station, in the southern part of Madison County, the thermometer marked the extreme low temperature of -4° F. during the winter of 1878-'79, while at Woodville, only about two degrees farther south, the lowest temperature noted was 14° F., or a difference of 18°.

this regard. On the contrary, the facts all show that the season was a late one, for April frosts retarded the starting of cotton in those very sections of Alabama where the worms were first found; while it is the unanimous opinion of planters in South Texas, where the worms were first noticed, that cotton was from two to three weeks later in 1879 than usual. It will not surprise me, for these reasons, to learn in future that the first worms may be found even earlier than here stated.

In most cases of the first appearance of the worms, specimens were received and examined by me so as to leave no doubt as to their identity. In the cases observed by Mr. Schwarz the plants were from one to two feet high, not yet blooming and with all the leaves tender.

The first worms are always comparatively few in number and in isolated spots. They are, therefore, easily overlooked by all who do not take particular pains to search for them. From such spots as centers the worms multiply and spread in subsequent generations, with greater or less rapidity, according as the conditions are favorable or otherwise. Such increase and spread may be confined to some part of a given county until the cotton is nearly ruined before the cotton in the rest of the county is affected. The worms will then first appear in the remainder much more suddenly and numerously than they did in the former, the parent moths migrating thereto in beevies. As a rule, however, the spread in the southern portion of the belt is gradual and the worm in destructive numbers is preceded by one or more scattering generations in the same field.

Other things being equal, the worm must appear earliest in the southernmost latitudes, since extended observations on the appearance of other insects show that there is retardation of from four to seven days with each degree of latitude northward.*

There is, in normal seasons of little injury to the crop, a similar retardation northward in the appearance of the Cotton Worm within the southern portion of the belt, corresponding in some measure with the growth and development of the plant; and it is a notable fact that the worm is seldom noticed and never in great numbers before the plant begins to bloom. What is generally under these circumstances called the first brood or "crop" has been preceded by at least one and often two generations sparsely distributed over the fields. Yet in years when the worm abounds to a disastrous extent in the southern portion of the belt, its appearance in the northern or temporary portion cannot be counted on with any certainty as to time, because it is always the result of migrations in the winged state, and these migrations may be more or less extended according to circumstances. Between the first appearance of the worm in the southern and northern portions of the belt there is, therefore, a marked difference ordinarily observable, it being in the latter much later and in far greater numbers.

* *Vide* remarks on time of appearance of the Northern Army Worm and hatching of locusts. *Mo. Ent. Report VIII*; p. 47; 1st Rep. U. S. E. C., p. 232.

6. CONDITION OF SOIL AND PLANT CONNECTED WITH THE APPEARANCE OF THE FIRST WORMS.

Having seen that the worms first appear in parts of the southern portion of the cotton belt at a much earlier date than previously supposed, we will now briefly consider the conditions of soil and of the plant connected with this first appearance. In glancing over the reports on this subject in answer to my questions, I find a remarkable unanimity of opinion corresponding with what Mr. Schwarz has observed and with the general experience collected. It is that the earliest worms of the season are confined to fields on the "low lands" where the plants are naturally more thrifty and more advanced than on any other soil. Low lands where cotton is planted in Texas and Louisiana comprise the so-called bottom lands of the rivers, and on such lands the soil is always a very rich alluvium and never sandy. Farther east, however, low lands are frequently sandy and the bottom formation of alluvial soil is less common than in Texas and Louisiana. This holds especially true of Florida, where the soil is exclusively sandy, more or less mixed with decayed vegetable matter. In the latter State fields on "hummock land" and near the edges of ponds or lakes replace the bottom lands of Texas and Louisiana. The rule of the first appearance on such low, rich, and moist lands does not apply alone to the extensive area of such land in the southern portion of the belt, but also to similar low places in particular parts of plantations in the whole cotton-growing country, the first worms on any plantation always being noticeable in such low spots.

The general rule, however, is not without exception, for on the sea islands off the coast of Georgia and South Carolina, where, in former years, the worms always appeared early, the soil in which cotton was and is to a limited extent still cultivated cannot be called low land. All low parts on these islands are occupied by marshes, and are unfit for cultivation, and the soil of the cotton fields is what is termed dry hummock land. Again, Mr. Schwarz found a very early appearance in Lavaca County, in Southern Texas, where the country is several hundred feet above the river bottoms in the same latitude and consists of open and rolling prairies. The worms were observed there in a field situated on top of one of the highest hills, and they have been observed there at similarly early dates in past years. The soil is, however, of that rich black nature peculiar to one part of the South Texan prairies.

A second circumstance which, according to the unanimous reports of planters and observers, appears to necessarily accompany the early appearance of the worms is that the cotton plants must be in a well-advanced and luxuriant condition. The earliest worms are never known to appear in fields in which the growth of the plants has been retarded

from one cause or another, as, for instance, late planting, the attacks of plant-lice, overflow, poor, exhausted, or sandy soil, &c.

A third fact is worthy of mention in connection with this early appearance, viz: that in open countries, or in countries where the prevailing soil is low and rich, there is almost always a gin-house or other building, a hay stack or some other shelter near by where the moths have to all appearance hibernated. Of the five localities in South Texas where the first worms were observed by Mr. Schwarz last spring, three were in the immediate vicinity of gin-houses, with no other building, fence, or tree in the neighborhood. In the fourth a gin-house and other buildings, as well as trees, were close by; while in the fifth (that in Lavaca County, already mentioned) the nearest object which could have served for the hibernation of the parent moth was an open stable about one hundred yards distant, but covered with a thick thatch of hay.

In all cases observed or reported the first worms occupy but a limited patch in the field, and are not scattered over the whole field or over large portions of a plantation, as is the case with subsequent generations. The extent of this patch seldom exceeds two acres and sometimes does not embrace one-fifth of an acre.

Still a fourth circumstance connected with the appearance of the first worms is noticeable, and one that, as we shall see farther on, has much importance from the practical side. It is that they recur year after year not only in the same counties but also in exactly the same spots.

The condition of the plant has already been alluded to. In every case it was luxuriant, advanced, and vigorous. This condition of the plant has so much to do with the matter under consideration that there must be a cause for it, whether in the greater attraction for the moth possessed by such plants or the greater facility with which the eggs hatch or the worms develop upon the same; for when produced artificially by the use of manures and good cultivation, it may, and often does, have the same effect and counteracts the otherwise unfavorable condition of soil and location.

As throwing light on the subject and as a rational explanation of the facts, it is well to remember that the most advanced and luxuriant plants most copiously exude from the secretory glands the sweet fluid upon which the moths feed and by which, it is fair to presume, they are attracted; also that the moths' fondness for shade and moisture is gratified in such low places where the cotton is rank. These places are also just those where the dews are heaviest, and the facts which follow render it quite certain that moisture aids both the hatching and the development of the worm. Another suggestion may here be made that also helps in the explanation: the natural enemies of the worm, especially the ants, are less abundant in low, wet land than in that which is higher and drier. They will, therefore, be less efficient in destroying the young worms, which for this reason will stand a better chance of developing unchecked.

7. WET WEATHER FAVORS THE DEVELOPMENT OF THE WORMS.

In the foregoing pages we have seen that the insect both in its larva and perfect states has a predilection for low, moist ground, where the cotton is luxuriant. We may safely infer, therefore, that the meteorological influences that produce over large areas the conditions thus described for limited areas will prove favorable to the development of the worms; and, indeed, it is the uniform testimony and experience of all who have closely observed the facts that wet weather is favorable and dry weather unfavorable thereto.*

We have not to deal here with the cold rains that characterize the Southern winter, and sometimes occur as late as the beginning of May. The influence of this weather on the hibernating moth has not been definitely ascertained, but it is more than probable that, when occurring late in spring, especially if accompanied by a "norther," it may prove as injurious to the first generation of worms as it is known to be to the cotton plant. We have to deal rather with that broiling and humid state of the atmosphere consequent upon frequent showers and a clouded sky during the summer months or later. The earth may be said to steam and the air is full of vapor. The influence of such weather is twofold, viz, direct and indirect.

Its direct influences may, perhaps, best be illustrated by citing, in contrast, the effects of dry weather, which effects I have had an excellent opportunity of watching and studying the present year. As witnessed in the field, a large portion of the eggs during dry weather actually desiccate and fail to hatch. The worms are less active, and wanting in vitality; they drop more easily to the ground, and are so affected by the dry, heated surface that, in almost every instance, they fail to regain the plant. While vigor and vitality are thus impaired, the development during such weather is unduly hastened. The worms, for the most part, web up prematurely and fail to effect the change to chrysalis, generally dying in the act, half-worm, half-chrysalis. The chrysalides, in case the transformation was successful, show a great tendency to rot, while the moths, which hatch from the comparatively few that remain sound, find scarcely any food in the cotton field, as the glands, already described (p. 15), are almost entirely wanting in honey during very dry weather. Nourishment and fecundity being correlated, it is more than probable that the moths, poorly nourished, will lay fewer eggs under such circumstances. All the effects described are intensified and become most marked during extreme drouth, so that frequently at the end of a dry spell, such as is not infrequent in July and early August, not a worm can be found. A rainy season, following such a spell, will produce a

* Severe rains, especially those accompanied by gales of wind, such as occur occasionally in the South, especially during the autumnal equinox, have been known to kill the worms, beating them down and sweeping them into windrows and heaps. Such was the case in Mississippi in 1825, Matagorda County, Texas, on September 6, 1875, and in the Bahamas on October 1st, 1886. But in these and similar cases the destruction of the worms was always accompanied by the utter loss of the crop.

most noticeable change. Its effects are almost magical. The plants freshen up, and the moths simultaneously become active; their eggs hatch freely, and the worms are so voracious and active that they soon destroy the new leaves or "top crop" and then, of necessity, work on the older ones.

The effects of dryness as here described are equally noticeable when produced artificially. Experiments upon plants growing in the field, but inclosed in muslin-covered frames, have produced all the unhealthy conditions of the insect, simply because the covering prevented the normal precipitations of dew upon the plants; while in vivaria the injurious effects of a dry atmosphere have been equally noticeable. In the dry, hot air of the Bahamas the worms are reported as often dying from the heat in numbers on the plant; a fact which would indicate that our climate is more favorable to their welfare than that of those islands; for the worms seldom, if ever, die from excessive heat in this country, except as they fall upon the heated surface of the ground.

The indirect influences of wet weather, first pointed out by the writer last July in some remarks before the Mobile Cotton Exchange,* are even more potent in favoring the development of the worms. They consist in the comparative immunity which the pest enjoys during such weather from its numerous natural enemies, presently to be mentioned, all of which are prevented during wet weather from working with the energy and activity they display during dry weather. This holds especially true of birds and ants, the latter of which not only hie to their nests during such weather, but are often drowned in countless numbers in open fields during heavy showers. Few who have not carefully observed the facts can appreciate the results of the non-working, even for a few short days, of these natural checks to a species so remarkably prolific and quick of growth as our *Aletia*.

It may also be remarked in this connection that wet weather is unfavorable to the poisoning of the worms, and prevents the working of cotton, which working, as will be shown further on, also helps to destroy them.

8. NUMBER OF ANNUAL GENERATIONS.

The general impression and belief that prevails in the South is that there are, in those sections where the worm is most injurious, three broods or generations, or, as the planter puts it, "crops," each year. This statement of the case has also been accepted as correct by most previous writers on the subject.† It is, however, essentially erroneous so far as the Southern portion of the cotton-belt is concerned, as the earlier and later generations are not taken into account but overlooked. The appearance of the first generation has already been discussed (*ante*, p. 17), and it occurs during the latter part of April and in May in the

* See *Mobile Register*, July 10, 1879.

† Dr. Phares is the only writer who has, so far as I can learn, recorded as many as six generations from July 6, 1869, till frost.—(*Rural Carolinian*, I, p. 695.)

more southern portions of the belt. One generation follows another continuously from that time on just so long as there are any leaves to be devoured, and I have, by protecting both plant and insect from frost, kept the moths ovipositing in the city of Washington all through November; while the worms, under like conditions, have hatched through the early part of December, matured, and spun up about Christmas time.

Careful observations and experiments the present year in South Texas show that at least seven, and probably even more, annual generations are produced there. The first two generations are generally well separated, but, owing to the irregularity in egg laying and in individual development, the later generations so cross each other, that the insect may be found in all stages in the same field at one and the same time. This was particularly noticeable last summer from the middle of July on. Yet the succession of broods may be recognized by the condition of the bulk of the specimens in the field or by confining the insects for the better watching of them.

The first generation, as we have seen, is confined to spots. The second generation is more dispersed, but still restricted to areas in the vicinity of the hibernating centers. The third generation of worms may become, under favoring conditions, not only widespread but disastrous, and the moths produced from them so numerous that they acquire the migrating habit. This generation appears in South Texas during the latter part of June, and in South Alabama and Georgia somewhat later. This is usually the supposed first brood in those sections, *i. e.*, the first which attracts general attention. The subsequent generations naturally become more and more widespread, and the increase during last July and August was noticeable in the face of meteorological conditions unfavorable thereto. The worms during these months will appear in those fields in which they did not appear earlier, as on sandy, elevated prairies, soils or lands where the growth of the plant was retarded from late planting, overflowing, the injury of the plant-lice, or whatever cause. If the weather be favorable, this August generation will, when unmolested, carry ruin in its wake. Did one generation follow another in the natural ratio of multiplication, such is the fecundity of the species, that there would be no hope of profitably cultivating cotton. Fortunately for man, some of the earlier generations are liable to be so effectually kept in check by natural enemies and other adverse influences that they become innocuous and frequently escape notice. This fact was strikingly illustrated last May in Colorado and Lavaca Counties, in Texas, where the second generation which hatched in sufficient numbers in most fields to create alarm, nevertheless vanished before its enemies so completely, that it was difficult a little later to find a perfect chrysalis.

That this second generation may exceptionally become very injurious is shown from records, to the effect that in the early part of June, while the cotton-stem was yet tender, whole plantations in the low bottom

lands of Louisiana have been eaten to the ground; but that it more often proves harmless, as it did the present year, is probable for various reasons. The plant-lice, which are apt to be very numerous on the very young cotton, partially disappear before their natural enemies by the time this second brood of worms is developing. The ants, which were previously supplied with food by the plant-lice, have now multiplied, and are forced, by the decrease of the aphides, to seek other food. They are consequently more effectual in destroying the young worms. All the other enemies of the worm are also more active during the month of June, and gregarious birds, like the blackbirds and ricebirds, are very common during that month, but generally leave the fields later.

In the northern portion of the cotton belt the number of annual generations is, of course, fewer, and will vary according to the date of the incoming of moths from the further south, and according to other circumstances. The generations are not only fewer, therefore, but more easily separated and defined.

9. MIGRATIONS AND POWER OF FLIGHT OF THE MOTH.

Many persons, noting the short and clumsy though rapid and darting flight of the moth, when disturbed during the day-time, get the idea that it is incapable of extended flight. But it has great power of wing, and its migrating habits are abundantly attested. It has been observed in numbers, far out at sea, and captured in autumn off the coast of New England, around Chicago and around Buffalo—the species being identified by competent entomologists like Packard, Burgess, Grote and Westcott. I have known it to do considerable injury during September to peaches in Kansas, and to ruin acres of cantelopes during the same month as far north as Racine, Wis. That it is aided in these distant flights by favoring winds there can be no doubt, but that it does not depend on them for dispersion is equally certain.

Dr. D. L. Phares records the destruction by the worms, of cotton the first year planted, eighty miles from any point where cotton had been grown before; while Mr. H. P. Bee (see letter in Appendix) shows that they appeared in Mexico on cotton planted two hundred miles from any other fields. Numerous similar cases might be mentioned.

The migrating habit is common to many insects and other animals, but is almost always associated with excessive multiplication. Such is likewise the case with *Aletia*, as the observations of the past year have clearly shown. So long as the worms are not numerous enough to materially riddle the cotton, the moths produced from them busy themselves with ovipositing in the neighborhood where they were born, spreading only comparatively short distances on all sides; but whenever the cotton is well "ragged," then the moths acquire the migrating habit and appear in numbers everywhere—in town and village, and at lights far away from cotton-fields. The time of year when this migra-

ting habit is acquired varies, but it is rarely till after the third generation of worms or the latter part of June and fore part of July in South Texas; while it is most pronounced during the autumn months. At such times, the moths may be noticed, during cloudy days, starting off by rapid flight and ascending high in the air till lost to sight; and the contrast between this movement and the darting and hiding of the normal day-flight is quite striking to any one who has witnessed it.

10. HIBERNATION.

No question connected with the Cotton Worm has given rise to more speculation than that of the hibernation of the insect, and this fact at once finds its explanation in the difficulty that surrounds the subject.

As partly illustrating this difficulty it will be well to elaborate the statements made in a paper read by the writer before the National Academy of Science at its meeting in Washington last spring.

There are three principal theories on the subject that are worthy of consideration, and that are held by those with whom I have come in contact, or with whom I have corresponded. These are:—

1st, That it hibernates in the chrysalis state.

2d, That it hibernates as a moth.

3d, That it does not hibernate in any part of our cotton-growing States, but comes into them on the wing from warmer climates where the cotton-plant is perennial.

Some few persons think that it winters in the egg state in cotton-seed or on the dead stalk of the plant; but such views may be disposed of by the statement that they are unsupported by even the appearance of fact.

At first blush it would seem easy enough to dispel whichever of these theories is erroneous and settle the question under consideration by a few simple facts of observation. The trouble is, however, to get at the facts.

About one-fourth of the intelligent people of the South hold the opinion that this *Aletia* hibernates in the chrysalis state, some believing that it does so above ground, others that it retreats beneath the surface of the ground. It has generally been stated by the writers on this insect that the chrysalis could not endure the slightest frost. I have been able to prove that it will suffer with impunity a temperature of from five to ten degrees below the freezing point, but that it cannot withstand a lower temperature; and all those chrysalides which do not give out the moth before severe cold weather sets in perish beyond any doubt. How easily men are misled even on this point, however, may be gathered from the fact that Dr. E. H. Anderson, of Kirkwood, Miss., a most intelligent observer and experienced cotton-planter, kept what he believed to be living specimens until after the severe cold of December last. A careful examination proved that the lifelike motions of such chrysalides were due to the living pupa which they contained of one of the parasites

(*Pimpla conquisitor*) presently to be described. The larger proportion of chrysalides that are not empty after a severe frost has occurred are infested with some kind of parasite, though many of them have perished from the effects of the frost and are either rotten or mouldy.

Any number of intelligent planters insist that they plow up the chrysalides in spring, and the belief that the last brood works beneath the ground, out of reach of frost, is very firmly held by some of the most experienced cotton-growers; but in every instance that has come to my knowledge the chrysalides thus plowed up have proved to belong to other species, most of them of the same family, and many of them having a sufficiently close resemblance to those of *Aletia* to confound any but the most skilled and experienced entomologist. As an illustration of the ease with which erroneous conclusions can be drawn from mistaken identity, I will here quote part of a letter received last spring from Prof. J. E. Willet, one of our observers who has particularly interested himself in this subject. "I have received to-night," writes Professor Willet, "from Rev. Robert Harris, of Cairo, Thomas County, Georgia, a small tin box inclosing 25 chrysalides, which I forward you by mail. Mr. Harris is an ardent believer in the subterranean hibernation of the chrysalis of *Aletia argillacea*. I transcribe the portion of his letter pertinent to the case:

"CAIRO, GA., February 22, 1879. "

"Washington's birthday and victory. *Perseverantia vincit*. The facts drive "analogy" to the wall. Here they are: 25 cotton-worm chrysalides ploughed up out of the ground in a field that was riddled by the insects last fall.

"This is unimpeachable evidence, and in the opinion of the court is amply sufficient to convict the prisoner."

"The chrysalides," continues Professor Willet, "appear to my eye very like *Aletia* chrysalides which I have in spirits, and I await your verdict with interest."

The chrysalides referred to in this instance resemble those of *Aletia* so thoroughly in form, size, and general appearance that they might have been mistaken therefor even by some entomologists; yet, from certain minute structural differences, easily observable with a good lens, I was able at once to decide that they belonged to another insect, the *Aspila virescens* of Fabricius, a beautiful moth, with olivaceous primaries, marked with three distinct pale transverse lines, relieved by coincident deeper shades, the translucent green larva of which, speckled with minute pale fleshy elevations, I have found feeding on *Solanum sieglinge* in Saint Louis.*

* I append a description of the larva of *Aspila virescens*:

Smooth, soft, translucent, with the normal complement of 16 legs. Color either green or lilaceous. Finely speckled, with pale yellowish spots (appearing under the lens as fleshy elevations), arranged in a somewhat longitudinal manner, and forming along the stigmatal region a tolerably well-marked band; the stigmata, which are in the upper portion of this band, being black, with a caraneous center and white annulation. Pimpliferous spots in normal position, very small, dark, with a paler annulation; the hairs fine and translucent. The two posterior joints somewhat squarely cut off. Head, thoracic legs, and cervical shield polished and slightly more yellow than body.

Full grown in July; imago issuing in August of same year.

There are many species of night-flying moths which go through their transformations beneath the ground, and there hibernate in the chrysalis state. The leaves of the cotton-plant are palatable to a very large number of such, while the Boll-worm (*Heliothis armigera*) and the "Grass-worm" (*Laphrygma frugiperda*), which thus transform, are sometimes very abundant in a cotton field. It is not at all surprising, therefore, that the chrysalides should be plowed or dug up in land planted to cotton. All of them, upon careful scrutiny, will be found to differ from the chrysalis of *Aletia*, which may be distinguished by its slender form, and particularly by the tip of the body with its armature, as shown in Fig. 4, p. 13. In short, the nature of the *Aletia* chrysalis effectually prevents it from working beneath the ground, except where, dropping out of its cocoon, it happens to fall into some crack or crevice, and thus wriggle beneath the surface. It is also contrary to all analogy that a chrysalis normally found above ground in a cocoon should work beneath the soil; for all insects that pupate under ground descend while in the larva state.

Experiments which I have repeatedly made prove that the *Aletia* chrysalis, when placed under ground, either rots and perishes or the moth, if in a sufficiently advanced state when the chrysalis is buried, will vainly attempt to escape and push through its unnatural surroundings.

Regarding the ability of the moth to survive the winter, nearly one-half of the more intelligent correspondents state that they have known the moth to be found flying during warm days in the winter, and that it consequently hibernates in that state. Mr. John T. Humphreys, of Morganton, N. C., who was for awhile employed by the State of Georgia in entomological work, says that he has absolute proof of the hibernation of the moth.

Page after page of testimony and experience from the most competent and reliable planters might be adduced in support of the fact that the moth is to be seen either hidden in sheltered situations or flying during the milder weather of winter, and in spring, in all of the southern portion of the belt. The situation in which it is most often reported as sheltering are under the shingles of gin-houses, under rails, and under the loose bark and in the hollows of trees and prostrate logs. In old pine stumps the sap-wood separates from the heart-wood and forms excellent retreats for this purpose. The general hue of the large scales of pine bark is sufficiently close to that of the moth to make the resemblance protective. A dense forest of Long-leaved pines also modifies and equalizes the winter temperature. These facts would lead one to suppose that pine forests offer unusually favorable conditions for hibernation, and Mr. Humphreys has, in fact, found the moth hibernating under pine scales, while some of my most reliable correspondents report having seen the moths sporting in great numbers in the edges of pine forests during the month of March.

Nevertheless, the persistent search by Mr. Schwarz last winter,* under

* Mr. Schwarz traveled throughout the southern portion of the belt, and visited the Bahamas, with the special object of learning the winter quarters of the moth.

my direction, while yet connected with the Department of Agriculture, failed to reveal the moth under pine bark; whereby I was led to the conclusion that it seeks winter shelter some distance from the ground. It has been reported by some correspondents in greatest numbers in swamps of sweet gum, oak, magnolia, poplar, &c., such as are found in Southern Alabama. These swamps are warm, moist, and miasmatic, and the moths are said to have been seen literally packed together in a torpid state in the hollows and burrows made in rotting logs by boring larvæ.

The evidence on this point of the hibernation of the moth would be overwhelming did it come from scientific observers; but, unfortunately, allied species are so often and so easily mistaken for *Aletia* that doubt still surrounds the subject. The liability to confound hibernating species is all the greater in that characteristic markings are more or less effaced or faded. The *Hypena scabralis* (Fabr.),* a moth, belonging to a different family (*Pyralidæ*), and which hibernates in the imago state all over the country, is especially common in the Southern States, and large numbers have been sent to me as the genuine *Aletia*. It is nearly of the same size and form, and while normally of a darker brown, faded hibernating specimens are easily mistaken for the Cotton Moth because of undulating darker lines across the front, somewhat similar to those on the latter. Its palpi are longer and snout-like, and its front wings invariably lack the dark discal spot and the white specks (see p. 14) characteristic of *Aletia*.

Phoberia atomaris Hübn., and many other similar moths, have been forwarded with the remark that they were the Cotton Moth; while *Leucania unipuncta* Haw., the parent of the Northern Army Worm, which feeds only on grasses and cereals, is everywhere found in the South during winter, and, on account of its great similarity in color to *Aletia*

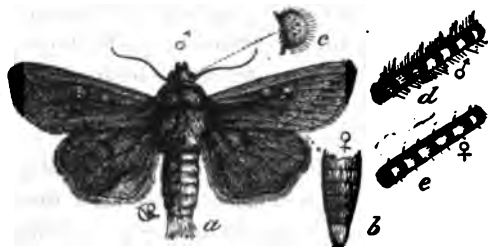


FIG. 8.—ARMY WORM MOTH: a, male moth; b, abdomen of female—nat. size; c, eye; d, base of male antenna; e, base of female antenna—enlarged. (After Riley.)

and of a white discal spot relieved with a dark shade on the front wings that heightens the general resemblance, is more often mistaken therefor than any other. It is more robust than *Aletia*, and a comparison of the accompanying illustration (Fig. 8 with Fig. 7, p. 15) will show the other differences. Seeing how easily non-entomologists are misled by general resemblances, I would again lay stress on the readily-observed char-

* The *Platyhypena scabra* (Fabr.) of Grote's List. Its larva is grass-green in color with a medio-dorsal and subdorsal lines of a darker green, the latter bordered below by a whitish line. It is cylindrical and with but three pairs of abdominal prolegs. It feeds on clover, and also on *Robinia*. The chrysalis is formed in some sheltered situation and surrounded with white silken threads; is dark and slender like that of *Aletia*, but the tip is armed with two strong, slightly diverging spines. In Missouri this chrysalis may be found under bark during winter, and it doubtless hibernates in both chrysalis and imago state in the South.

acters underlined on page 14, by which *Aletia* may always be recognized. Where they are absent it may be safely taken for granted that other species are in question. From this danger of confounding species it is evident that ordinary reports lose, when unaccompanied by specimens, much of their value, and must always be taken *cum grano salis*.

Yet, after making due allowance for possible error, the number of intelligent planters whom I have conversed with, and who, having long and thorough acquaintance with the moth, feel positive of their ability to distinguish it and of having seen it during the winter, is so great as to leave little doubt of the fact, while the added testimony of Professor Grote, who is such authority on moths that he could not thus confound species, and who states that he has found the *Aletia* in Alabama during mild winter weather, should dispel even that little doubt, and we may safely consider as proven that the moth does survive the winter up to the end of March. The general experience of correspondents is, however, that after March these hibernating moths are no longer to be seen, and no one knows what becomes of them between this time and the appearance of the first worms.

The difficulty felt in bridging this gap, together with the progress of injury from the south northward, has given rise to the theory that the species cannot survive the winter in this country, and must necessarily come each year on the wing from some exotic country where cotton is perennial. Mr. Robert Chisolm, of Beaufort, S. C., seems to have been the first to suggest the theory, but the first published statement of it that I can find is by a Mr. Gorham, who, in 1852, distinctly says:* “My speculations on the nature and habits of the cotton fly have led me to adopt the following hypothesis: That it is a native of tropical climates, and never can pass a single winter beyond them, consequently never can become naturalized in the United States, or anywhere else where the cotton plant is not perennial.”

Two years later it was more fully set forth by Dr. W. I. Burnett† from facts communicated by Mr. Chisolm, and lastly it was again urged, as original, by Professor Grote, in 1874, in his paper, already cited (p. 8). Professor Grote's conclusions were “*that it dies out every year (with its food plant), that it occurs in the cotton belt of the Southern States, and that its next appearance is the result of immigration.*”‡

The principal arguments urged in support of the theory by Professor Grote are [1] the *sudden* appearance of the moth in quantities; [2] the first appearance of the worms so late as the latter part of June; [3] the

* De Bow's Industrial Resources of the Southern and Western States, 1852, vol. i, p. 169.

† Proc. Bost. Soc. Nat. Hist., 1854, vol. iv, pp. 316, 317.

‡ It was my privilege to follow the reading of this paper with some remarks expressing my general appreciation of it, but urging at the same time some qualifications of the theory, and the belief that the insect hibernated in the more southern portion of the belt. These remarks seem to have had some weight, for in the printed copy of the paper in the Proceedings of the Association a qualifying clause (not in the paper as read or as printed at the time in the *New York Tribune*) is added, admitting the possibility of hibernation in Florida and Southern Texas. Professor Grote based his views on an experience had in what is known as the central cotton belt of Georgia and Alabama. The exact northern or southern limits of this belt are not stated, but it includes most of the canebrake region of the latter

absence of parasitic checks; [4] the highly probable exotic origin of the species and its introduction into the States; and [5] the power of flight and migratory habits of the moth. The first three lose much of their force from the facts adduced in this bulletin, since [1] in the southern portion of the belt* the sudden appearance is more apparent than real; [2] the worms appear in April; and [3] they have numerous parasitic checks. There is also little force in the fact of original introduction from some foreign country, since most of our worst insect pests that are now acclimated and established with us were originally introduced from abroad; while [4] the migratory habit, as we have seen, is not developed in the first moths. Arguments urged by others in favor of the theory are [6] the periodical visitations and intervals of immunity; [7] the short life of the moth; and [8] the failure of those who have tried to keep it through the winter.

To these it may be replied that [6] many other indigenous insects abound during certain years and are unknown in others, and that these changes are due to the working of well known laws; that periodicity in the appearance of Aletia is largely imaginary, because it either refers only to bad years and takes no stock of small numbers, or else is local. The investigations of the Commission show that the worm has been in some parts of the South ever since the civil war, and there is no reason to suppose that it was not annually to be found in fewer or larger numbers prior thereto. [7] The short life of the moth of the summer generations is no criterion for that of the last or hibernating brood, since any number of species which produce several annual generations and have but a brief span of life in the imago state in summer are known to hibernate in this state. [8] It is extremely difficult to attain, in a room, the proper conditions of moisture and freshness that belong to a sylvan atmosphere, and I have never been able to keep other Lepidoptera which hibernate in the imago state alive through the whole winter in such artificial situation, though I have tried with both *Danais archippus* and *Paphia glycerium*. For this reason it will always be next to impossible to get *absolute and incontrovertible* proof of the hibernation of Aletia by watching the moths from Fall till they oviposit the following year, but it may be truly said that if the hibernation of other species rested on equally absolute proof, there is not one among the Lepidoptera, or other orders for that matter, that could be said to hibernate. One other argument that has been made in favor of the theory may lastly be mentioned. It is that during the late war no cotton was grown for three years in some sections of the South, and that the first crop raised thereafter was infested. Professor

State, and extends south of what, in a broader way, I have defined as the southern or hibernating portion of the whole cotton belt. The arguments against the theory of annual immigration are therefore based on experience gained, in great part, in the same latitude and regions referred to by Professor Grote. While yet connected with the Department of Agriculture, I directed Professor Grote to pay particular attention to this question of hibernation, and it is due him to state that his investigations in Southern Georgia, according to his report submitted, led him to admit the possibility of the moth's hibernating there, though as late as last January he was reported as having confirmed "his theory" that "the fly comes from the West Indies with the south winds every year."—(*Pop. Sci. Monthly* vol. xiv, p. 408.)

* Roughly defined in the Introduction.

Comstock took particular pains to make inquiries on this head, and found that some patches of cotton had been grown every year in such sections.

In favor of hibernation in the southern portion of the cotton belt may be urged [1] the appearance of the moth on the wing during mild winter weather, and its being found torpid in sheltered situations, as is insisted on by so many; [2] the first appearance of the worms in very small numbers, and in the spring of the year, as attested by recent observations; [3] their reappearance each year in the same spots, not on the sea-coast nearest to the tropical zone, where we should expect them on the theory of annual incoming, but at various points far inland; [4] the coming of the moths in large numbers and as immigrants into the northern portions of the belt, being always preceded by the appearance of the worms and their gradual increase at some other, generally more southern or western, points; and [5] the decrease of cotton culture in Central America and the West Indies, as appears from market statistics, and the absolute absence of the worm in the Bahamas since 1866, as ascertained by Mr. Schwarz while there last spring.

The strongest fact against hibernation is, perhaps, the period elapsing between the disappearance of the moths in March and the first appearance of the worms, or, to put it in another form, the absence of the worms on the young and tender cotton. The period during which the species is not to be seen is already reduced by the facts given in this bulletin to less than one month instead of three, and this is much less than the time elapsing between the issuing from winter quarters of other well-known Lepidoptera that hibernate in the imago state, and the first appearance of their larvæ, numerous illustrations of which fact might be cited.

On the whole, therefore, the weight of evidence is strongly against the theory of annual extermination, in the southern part of the belt, and the fact of the hibernation of *Aletia* there may be said to rest on as good evidence as that of many other species in which it is admitted without question. Yet *Aletia* is beyond doubt killed out each winter in the northern portion of the cotton belt, and all the arguments in favor of annual extinction and incoming *de novo* have force when restricted to this section. Just where the separating line lies between extinction and survival is not so easy to decide, and for the present I can only refer to that given in the Introduction as the result of the investigation so far as it has gone. This conclusion that the moth does and can hibernate in the United States does not preclude its occasional incoming from foreign, more tropical countries, or the possibility of its being brought by favorable winds from such exterior regions, just as originally must have been the case when the species was first introduced. The facts indicate, however, that this kind of immigration is less frequent now-a-days than it was in the beginning of the century.

To sum up the evidence from present knowledge: *Aletia* never hibernates in either of the first three states of egg, larva, or chrysalis, and it survives the winter in the moth or imago state only in the southern portion of the cotton belt. My own investigations during the past two

years in every cotton-growing State in the Union, except South Carolina and Florida (which have been visited by Mr. Schwarz), together with the experience and testimony of both correspondents and special agents employed in the investigation, confirm me in these conclusions, and I will close the discussion with two other suggestions that grow out of this experience.

1. It is quite certain that by far the larger portion of the moths from the last brood of worms perish in various ways without perpetuating the species. All those which fly north of the cotton belt must needs thus perish, as doubtless do all those that attempt to hibernate in the northern portion of said belt. The evidence is strong that even in the hibernating portion of the belt only the exceptional few, more favored than the rest and remaining steadily torpid till early spring, survive to beget progeny. Those which are aroused to activity during the mild winter weather spend their force without finding compensating nourishment, as there are neither fruits, flowers, nor sweet-secreting glands at that season wherewith to break their long fast and sustain vitality. It is for these reasons that the worms are generally less injurious after mild and changeable winters and most to be dreaded after severe and steady ones, and it may very justly be argued, that did the larger proportion of the moths survive, there would be no chance to grow cotton. Like perishing of the bulk of most insects that hibernate above ground is, in fact, an acknowledged rule in entomology.

2. The localities where *Aletia* doubtless hibernates, and where, consequently, the earliest worms appear, seem to be more common in the western parts of the cotton belt than in the Atlantic States. Since the civil war the almost complete abandonment of cotton cultivation on the sea islands of the coast of Florida and Georgia has evidently reduced the number of favorable hibernating localities there, and in so far protected the more northern or western portion of the Atlantic States from the immigration of the moth from those quarters. In Texas, on the contrary, the cultivation of cotton has been constantly increasing since that time, and consecutaneously the number of hibernating points and the risk of serious harm there over extended areas have also increased.

11. NATURAL ENEMIES.

We have already seen that meteorological conditions may favor or retard the multiplication of the Cotton Worm, but that their influence is, in a great degree, indirect, *i. e.*, by favoring or retarding the work of the insect's natural enemies. Careful observations in the field for a single season will convince any one that these natural enemies are far more numerous than has hitherto been supposed, and that without their aid man would be powerless in his efforts to cope with an insect with such powers of multiplication as *Aletia* possesses. While it will be well to treat here with some fullness of the true parasites of the species, because they have been so generally overlooked, I shall pass the other

enemies with a bare indication of those that have been so far observed. The list will no doubt be greatly extended by future observations. I am strongly inclined to believe that the first generation of worms is less subject than later generations to the attacks of their worst enemies—birds and ants. The former are apt to overlook the few spots where the first worms appear, while the latter are too busy at that early season with the plant-lice which then abound. The converse will hold true of many of the true parasites, and the first worms are doubtless sometimes entirely extirpated by them.

Those who have carefully watched the worms in any given spot have been struck with the sudden disappearance from day to day of a certain proportion of them. This apparently mysterious disappearance is admirably set forth in the experiments made by Professor Willet with the yeast fungus, and quoted farther on. It frequently puzzled and baffled Mr. Schwarz in his efforts to watch the worms on certain special plants, and there can be no doubt that it is due mainly, if not entirely, to the efficient work of natural enemies, especially those that are nocturnal.

VERTEBRATES.

Among quadrupeds the Cotton Worm has few enemies of importance. Hogs are rather fond of it as attested by many planters. The Raccoon is also reported to have been seen eating the worms from the plants, and breaking these down in doing so. The Skunk and the Opossum have also been known to feed upon it. These animals can do little good except where the worms are in such large numbers that they travel over the ground and from field to field. Bats devour large numbers of the moths, and, in favorable localities, may be seen at evening time dashing over the cotton fields in pursuit of them.

Birds are of incalculable benefit, and it is probable that most of the insectivorous birds which prevail in the South feed at times on the species either in its larva, chrysalis, or moth state, but only those which have been observed to do so will here be mentioned.

All domestic birds as turkeys, chickens, guinea fowl, and geese are fond of them, and may be employed with benefit. Turkeys are the most efficient, but they get demoralized when locusts or grasshoppers are abundant, by running after these, which they greatly prefer to the worms. Prairie chickens and qualls often do good work in devouring the worms, while a Thrush (probably *Harporhynchus rufus* L.), the Rain Crow or Cuckoo (*Coccyus americanus* Bon.) Bluebird (*Sialia sialis*), Cardinal Grosbeak (*Cardinalis virginianus* Bon.), Mocking-bird (*Mimus polyglottus* L.), Blue jay (*Cyanurus cristatus* Sw.), Red-wing blackbird (*Agelaius phoeniceus* Vieill.), Rice bird (*Dolichonyx oryzivorus* L.), and Killdeer plover (*Aegialitis vocifera*), are more or less persistent in feeding upon them. The domestic birds and some of the wild species may be attracted to a field by scattering a little corn or other grain on the ground. The most effective help to man is rendered by the gregarious species such as the Rice birds and Blackbirds, and they have protected and saved fields near their favorite resorts or resting-places. The Rice

birds occur in large swarms only in the vicinity of swamps; the Black-birds are more generally distributed, but unfortunately they nearly all migrate northward in June from those localities which are most exposed to the attacks of the worms, and they seldom return again till after frost. It is quite amusing to watch how deftly they will extract the chrysalis from its leafy or silken covering. Of nocturnal birds, several, and among them the Night-hawks (*Chordeiles*), are supposed to feed on the moths, but the proof is necessarily difficult to obtain except by shooting and examination of their stomachs, and I cannot find that this has been done.

The introduction of the English Sparrow has been recommended by several writers. The experience so far had with it would indicate that little good is to be expected in this direction. A number were obtained from New York and let loose in 1870 at Macon Station, Ala., but did not colonize, while in Texas they seem unable to endure the intense summer heat, for, while they are found below latitude 30° in winter, they migrate north during the hotter months, or just when they would be most useful in the cotton field. It must also be borne in mind that this bird, except during the breeding season, is more graminivorous than insectivorous.

Of reptiles one meets an occasional tree-frog (genus *Hyla*) upon the plants, and these little creatures doubtless take their share of the worms. Other frogs, and reptiles generally, are extremely scarce in cotton fields.

INVERTEBRATES.

These consist principally of Hexapods or true insects, though some spiders (*Arachnidæ*) presumably assist, certain species of *Phalangium* and *Epeira* being frequently found on the plants. One species has often been seen devouring the worms, and deserves especial mention because of its frequency in all the States, except Florida, where Mr. Schwarz did not find it. This is the *Oxyopes viridans*, of Hentz, a beautiful, slender and green species. The notion, prevailing in some parts of the country, that this spider is confined to the cotton plant, is incorrect, as the species is also found abundantly on weeds, especially in moist places.

Predaceous Insects.

Of true insects which, from their well-known carnivorous propensities, might with safety be placed among the natural enemies of the Cotton Worm, there are a very great many, especially among the Coleoptera and Heteroptera; but I shall refer only to those which have been actually observed to feed upon them; and then note some of the species commonly found in the cotton field, and which presumably have the same habit.

HYMENOPTERA: WASPS, ANTS, &C.—In this order none are of greater importance than the ants. A careful observer, while going through any cotton field the latter part of summer, has no difficulty in observing the ants occupied in destroying the eggs of *Aletia*, or still more frequently in attacking the young worms that are helpless while



FIG. 9. *POLISTES RUBIGINOSA*: a, wasp, b, spring nest. (After Riley.)

in the act of molting, or in devouring the interior of the still more helpless chrysalids. Even old worms which, from cause whatsoever, once get to the ground, are almost sure to fall a prey to these persistent and voracious little animals; the writhings, jerkings, and jumpings of the worm being of no avail against the constantly increasing numbers of the enemy that come to the attack. Attractive as is the honey from the glands of the cotton plant to the Cotton Moth, it seems to attract few other insects, and even the ants, that have such a predilection for sweets, are only occasionally found partaking of it. The universal presence of ants on the cotton plants, and of their nests in the ground at the base of the plants, seems largely due to the similarly universal presence of the cotton plant-lice.

The ants are always to be seen busily occupied in obtaining sweets from these *Aphides*, while but few are noticed to be sucking the liquid secreted by the glands. Now the plant-lice rapidly decrease in number with the advance of hot weather, though they never disappear entirely from the plants. The ants, as summer advances, are thus deprived of a large portion of their principal food-supply, and as their colonies become more and more numerous with the progress of the season, they are obliged to seek other food. It is but natural, therefore, that they should fall to preying on the Cotton Worm. It has already been mentioned that rains hinder the working of the ants, and that storms destroy them. They will, therefore, prove most effectual in assisting man where they are most protected from heavy showers, as on new land where the soil is uneven, or in fields where there are stumps, trees, &c. The species concerned in the good work differ with locality, and are reserved for future study.* The Leaf-cutting ant (*Oecodoma ferens* Say), when it invades a cotton field makes a clean sweep of every worm or chrysalis, but it also ruins the plant, taking off leaves, blossoms, bolls, and tender stalks.

*The most common and effective species in the Southwest is the *Solenopsis geminata* Fabr., a small species averaging 2.8mm in length, and of a pale fuscous color, with a darker, piceous abdomen; another is *Dorymyrmex insanus* Buckley, var. *flavus*, both kindly determined by Rev. H. C. McCook. Among the DORYLIDÆ is *Labidus Harrieti* Hald., and *L. Melheimeri* Hald., as determined by Mr. E. T. Cresson.

While I have repeatedly seen the first-named species attacking worms that were upon the ground, I have but once, at Macon Station, Ala., witnessed it feeding on a young worm on the plant; but so many correspondents have witnessed the good work of ants (and it has been confirmed by both Professor

Certain Paper-wasps (genus *Polistes*)* and Digger Wasps (genus *Sphex*)† occasionally carry off a worm; but beyond these and *Vespa germanica* no other Hymenoptera have been observed or reported.

COLEOPTERA, OR BEETLES.—Of this order numerous species belonging to the families of Tiger-beetles (*Cicindelidæ*) and Ground-beetles (*Carabidæ*) have been observed to prey upon the worms, each species being represented by but a very small number of specimens when compared with the ants. These beetles are nevertheless among the most voracious insects known to us. Most of them are nocturnal in their habits, and are thus more apt to escape the attacks of birds. They devour their prey bodily, and as they are frequently met with in cotton fields very remote from

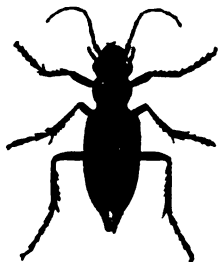


FIG. 10.—*TETRACHA VIRGINICA*.



FIG. 11.—*CICINDELA*.

their hiding places, they are probably attracted by the smell attending the worms. The following is a list of the species actually observed feeding thereon:‡ *Tetracha carolina* (Linn.), *T. virginica* (Linn.), *Cicindela circumscripta* Laf., *Helluomorpha laticornis* (Dej.), *H. texana* Lec., *Galerita atripes* Lec., *Brachinus* sp., *Aphelogenia furcata* (Lec.), *Callida decora* (Fabr.), *Loxandrus lucens* Chaud., *L. crenatus* Lec., *Pterostichus Sayi* Brull., and *Selenophorus laesus* Lec. In the larva state these beetles inhabit the ground, and cannot affect the Cotton Worm. A number of different Lady-



FIG. 12.—CONVERGENT LADYBIRD: a, larva; b, pupa; c, beetle. (After Riley.)

birds (*Coccinellidæ*), and especially the small obscure species with flocculent or cottony larvæ, belonging to the genus *Scymnus*, are constantly found on cotton, but I have never been able to satisfy myself that they prey either in the beetle or the larva state on cotton worms; nor have any of the observers of the Commission obtained proof that they do. The natural food of these beetles consists of the plant-lice, to the increase of which they form the principal check. Soldier-beetles (*Telephoridæ*) and "Fireflies" (*Lampyridæ*) are also quite common on cotton, especially *Chauliognathus pensylvanicus* (Fig. 13), and their larvæ are



Fig. 13.—*CHAULIOGNATHUS PENSYLVANICUS*: a, larva; b, enlarged head of same; c-h, mouth parts of same; i, beetle. (After Riley.)

well known to be predaceous; but these have not yet been found attack-

Comstock and Mr. Schwarz), that there can be no question as to the general correctness of the above conclusions, though it is doubtful whether a worm is ever attacked by ants except when, from the causes mentioned, it is exceptionally helpless. Again, some species of ants are more ferocious than others, and they will act differently in different localities; hence there is a difference of opinion among planters as to their influence, and Dr. Phares does not believe that they accomplish much good.

* *P. rubiginosa* St. F. and *P. bellicosa* Cress.

† *S. cærulea* De Geer, *S. pensylvanica* Linn and an undetermined species.

‡ Species of the following genera have been observed by Mr. Schwarz on cotton plants at night, but they were not seen feeding on the worms: *Olivina* and allied genera, *Loxopeza*, *Lebia*, *Agonoderus*, *Anisodactylus*, *Platynus*, and *Harpalus*.

ing Aletia, while the beetles are pollinivorous. A number of other beetles, as, for instance, *Collops quadrimaculatus* (Fabr.), having carnivorous habits, are found upon the plant, and may by further observation be added to the enemies of Aletia, while a minute yellowish-brown species (*Sericoderus flavidus* Lec.), belonging to the *Corylophidæ*, has been found feeding on the forming chrysalis while yet soft and helpless.

HETEROPTERA, OR HALF-WINGED BUGS.—Next to the ants in usefulness as natural checks are sundry species of rapacious or Soldier-bugs, as they are popularly called. These belong exclusively, so far as observed, to the families *Cydnidæ*, *Anthocoridae*, *Scutelleridæ*, and *Reduviidæ*. They suck out the juices of their prey by means of a short but sharp beak, and the young have precisely the same habits as the mature insects, though often differing greatly in appearance. They are almost all



FIG. 14.—*PODISUS SPINOSUS*: a, enlarged beak; b, bug, with right wings expanded. (After Riley.)

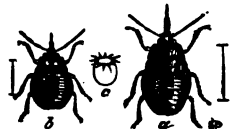


FIG. 15.—*PODISUS SPINOSUS*: a, pupa; b, larva; c, egg. (After Riley.)

active during the day, but a few work also at night. The species actually observed destroying cotton worms are: *Podisus cynicus* (Say), *P. spinosus* (Dall.), *Euschistus fissilis* Uhler, *Proxys punctulatus* (Beauv.), *Prionotus cristatus* (Linn.), *Apiomerus crassipes* (Fabr.), *Phymata erosa* (Linn.), *Melanolestes picipes* (H. Sch.), *Stenopoda cinerea* Lap. Also the following species, new to my cabinet, and kindly determined by Mr. P. R. Uhler, of Baltimore: *Oebalus pugnax* (Fabr.), *Repipta taurus* (Fabr.),



FIG. 16.—*SINEA DIADEMA*. (After Riley.)



FIG. 17.—*STIRETRUS FIMBRIATUS*. (After Riley.)

Aceratodes cornutus Burm., and *Zelus bilobus* (Say). The following species, commonly found in cotton fields but not yet actually observed to feed on the worms, may safely be regarded as having the habit, while several others might be added, some of which combine the carnivorous with the plant-feeding trait: *Stiretrus fimbriatus* (Say), var. *diana* (Fabr.), *Euschistus punctipes* (Say), *E. tristigmus* (Say), *Thyanta custator* (Fabr.), *Rhaphigaster hilaris* (Say), *Sinea diadema* (Fabr.) (Fig. 16), *Metapodius femoratus* (Fabr.), *Evangorus viridis* Uhler, *Merocoris distinctus* Dall., *Anasa armigera* Say, *Nezara pennsylvanica* De G., and *Triphleps insidiosus* (Say).

DIPTERA, OR TWO-WINGED FLIES.—In this Order the only species that attack the worms, and probably the moths also, belong to the *Asilidæ*, a family of large, fierce flies that pounce upon other insects as a hawk pounces upon other birds, and suck their substance by means of a strong beak. But two



FIG. 18.—*PROCTACANTHUS MILREERTI*. (After Riley.)

species—one the *Proctacanthus Milberti* Macq., Fig. 18, the other an undescribed *Asilus*—have been seen destroying the worm so far, though several belonging to the above-named genera and to *Promachus*, *Eraz*, and *Laphria* are not uncommon in cotton fields.

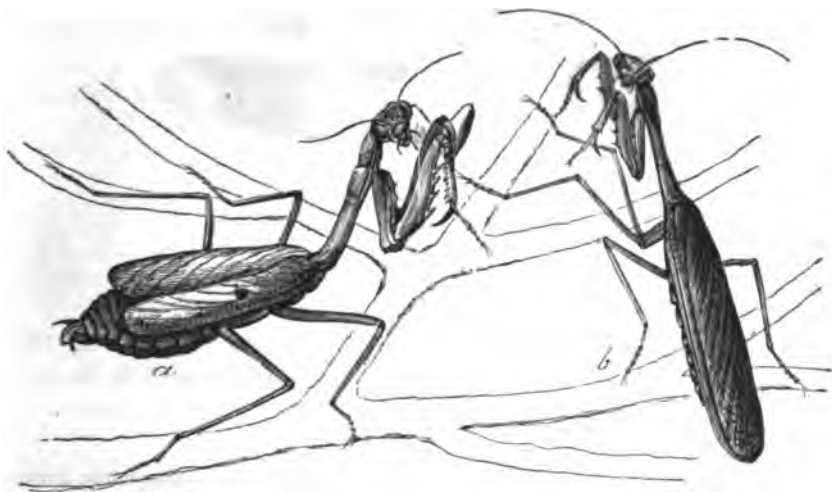


FIG. 19.—MANTIS CAROLINA: a, female; b, male. (After Riley.)

ORTHOPTERA, OR STRAIGHT-WINGED INSECTS.—The Carolina Mantis (*Mantis carolina* L., Fig. 19) is also occasionally found in such situations, and being purely predaceous, may be presumed to take an occasional Cotton Worm, though I have not yet seen it do so.

NEUROPTERA, OR NERVE-WINGED INSECTS.—The only species of this Order that are likely to prey upon Aletia belong to the Ant-lions (*Myrmelionidæ*), the Lace-

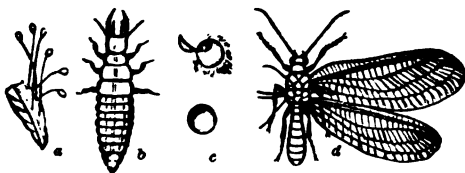


FIG. 20.—CHRYSOPE: a, eggs; b, larva; c, cocoons; d, fly with left wings detached. (After Westwood.)



FIG. 21.—CHRYSOPE with eggs.

wings (*Hemerobiidæ*), and the Dragon-Flies (*Libellulidæ*). The Ant-lions work in the larva state in pits in the ground and the constant plowing thereof will always prevent them from doing any material good, and they are naturally scarce.

The Lace-wings are numerous, but their larvæ feed, like the lady-birds, on the plant-lice, and have refused to touch cotton worms when confined in



FIG. 22.—MYRMELEON.



FIG. 23.—MYRMELEON LARVA.

boxes with them. The curious eggs of these flies, attached to the end

of a delicate filament (Fig. 27, *a*), are often supposed to be those of *Aletia*. The Dragon-flies or Mosquito-hawks are aquatic in the larva state, but



FIG. 24.—*LIBELLULA TRIMACULATA*. (After Packard.)

the perfect insects are active in their pursuit of prey while on the wing, and are reported on good authority to attack *Aletia* both in the worm and moth states.

Parasites.

It has very generally been believed that no true parasites were known to affect the Cotton Worm, and this belief has been used by Professor Grote, as we have already seen, as an argument in favor of the arrival of *Aletia de novo* from some exotic country whenever it appears with us. The belief was founded on the fact that no parasite had been recorded by name so as to be recognized by entomologists. Yet, as the sequence will show, two species at least have long been referred to without identification as infesting the chrysalis, a fact overlooked by myself and other entomologists, but which I became aware of as soon as I commenced to collect chronological data while yet in the Department of Agriculture. The list of true parasites had, however, been greatly extended prior to my leaving said department, and some of the species are quite effectual in destroying *Aletia*, especially during the latter part of the season.

Infesting the Egg.—*The Trichogramma Egg-parasite:* Attacking *Aletia* in its earliest stage, the unhatched egg, this winged atom must be, when abundant, a most effectual check, and the scarcity of the Cotton Worm in certain seasons may doubtless be partly ascribed to its work. It is at least known that a similar egg-parasite has in the New England States relieved the shade trees from the ravages of canker-worms—a good deed which the European sparrows, notwithstanding they received the credit for it, were unable to accomplish. The *Trichogramma* is a yellow fly, so small that were it not for its activity in jumping it could not be distinguished by the unaided eye as an animated being, and it finds sufficient nourishment in a single egg of the *Aletia* to support its growth and maturation. It emerges from a round hole which it gnaws through the egg-shell, and eggs infested by it or which have been destroyed by it may be recognized by their bluish or blackish color and the presence of this perforation. When examined under the microscope,

the perfect fly is found to be an object of much beauty, the hairs upon the wings being arranged in regular lines. Some specimens of both sexes—the ♂ may be distinguished by the bristly antennæ—were found to have one or more of the wings imperfectly developed, presenting the appearance of a paddle. I append a description for the benefit of the scientific reader :

TRICHOGRAMMA PRETIOSA Riley (*Can. Ent.*, vol. xi, p. 161).—Length about 0.3mm. Yellow, the eyes red, the wings hyaline. Head wider than the thorax; antennæ five-jointed, joints 3 and 4 in the ♀ forming an ovate mass, and together shorter than joint 2; joint 5 large, thickened, and very obliquely truncate; in the ♂ joints 3, 4, and 5 form a more or less distinct elongate club, beset with long bristles. Hairs of the wings arranged in about fifteen lines. Abdomen not so wide as the thorax, but as long as the head and thorax together; in the ♀ the sides subparallel and the apical joint suddenly narrowed to a point.

Differs from *Trichogramma minuta* Riley (Third Rep. Ins. Mo., p. 158, fig. 72, ♀) in its smaller size and uniform pale yellow color, and also in the form of the third and fourth joints of the antennæ. As defined, and figured by Westwood (*Intr. ii*, fig. 77→), the antennæ of *Trichogramma* are six-jointed. Walker, in his "Notes on the Chalcidie," pt. vi, p. 105, employing Förster's characters, says the antennæ are eight-jointed; but an examination of the figure of the type (*Trichogramma eranesceus*, l. c., p. 114) shows that one of the joints counted is the "annulus" above the scape, which I do not consider to be a true joint, and that what I have indicated as the apical joint, in agreement with Westwood, is represented in that figure as three coalesced joints. I have proposed the generic name of *Pentarthron* for *minuta* (*Rec. of Am. Ent.*, 1871, p. 8), but *Pentarthron* has been used by Wollaston for a genus of beetles, and until the allied genera are better characterized than at present, it is best to use the old genus *Trichogramma*, in all absolute characters of which *pretiosa* agrees.

This minute creature was first noticed by Professor Comstock in 1878, near Selma, Ala., and during the month of October last I found it quite common in Mississippi, Alabama, and Georgia, fully one-fifth of the eggs in some fields being infested. It is an interesting fact that an allied species infests the larva of an *Aleurodid* quite commonly found on the same leaves with the eggs of *Aletia*, and often mistaken therefor.

Infesting and issuing from the Worm.—*Two-winged flies*: Two species

of flies belonging to well known parasitic genera have been found to infest the worm. One of these is the common Flesh-fly, and a male specimen bred from *Aletia* does not differ* materially from small specimens obtained from the decaying insects found in the pitchers of the spotted pitcher-plant (*Sarracenia variolaris*), and to which I have given the name of *Sarcophaga sarracenia*.



FIG. 25.—*SARCOPHAGA SARRACENIA*: a, larva; b, pupa; c, fly; the hair-lines showing average natural lengths; d, enlarged head and first joint of larva, showing curved hooks, lower lip (g) and prothoracic spiracle; e, end of body of male, showing stigmata (f) and prolegs and vent; k, tarsal claws of fly with protecting pads; i, antenna of same. Allenlarged. (After Riley.)

These flies (Fig. 25) lay elongate and delicate eggs, which hatch very quickly. They sometimes hatch, in fact,

*Except in lacking the two bristles at the apex of the third segment of the abdomen which are prominent in *sarracenia* (type), and in other species, the specimen differs in no respect from those found to infest the Rocky Mountain Locust and *Caloptenus differentialis* (Locust Plague, etc., pp. 135-136; and First Am. Rep. U. S. Ent. Comm., p. 324). Although in the works here cited *sarracenia* is considered

within the oviduct, so that the fly gives birth to living maggots. The maggot penetrates the skin of the worm or the chrysalis, as the case may be, and feeds upon the fatty tissues within, acquiring full growth and issuing sometimes before but usually after its victim has transformed to the chrysalis state. Dropping to the ground, it burrows beneath the surface, and rapidly contracts to the pupa state, from which the perfect fly in due time issues. The species has been obtained from the Cotton Worm in Alabama, Georgia, and Texas, and is indeed widespread over the country. It is most abundant in autumn, and passes the winter in both the pupa and fly states. From the known preference of this fly for decaying or putrescent flesh, it is probable that the female is attracted more to diseased or injured chrysalides than to vigorous worms.

The other fly belongs to the genus *Tachina*, and appears to be an undescribed species. It measures about one-third of an inch in length, and is more robust and slightly larger than the common house-fly, from which, as well as from the *Sarcophaga* (which is less robust than the *Tachina*), it may be distinguished by having the bristle of the antennæ smooth and not hairy. These *Tachina* flies are more completely parasitic than the flesh-fly above mentioned, and their eggs are harder, more polished, and very firmly attached to the worm, usually just behind the head, where they cannot be molested. The larvæ or maggots have the same habits and mode of transformation as those of *Sarcophaga*, and the accompanying figure (Fig. 26) of *Tachina flavicauda* Riley, will serve to illustrate the flies.

FIG. 26.—YELLOW-TAILED TACHINA-FLY. (After Riley.)

Occasionally these maggots are not full fed, and do not destroy the *Aletia* till after it has assumed the chrysalis state, but ordinarily they issue from the worm itself, which is frequently infested by more than one. The species was reared from chrysalides sent by Professor Grote from Savannah and by others from various parts of the South, including the States of Alabama, Mississippi, and Texas. I append a description:

TACHINA ALETIÆ Riley (*Can. Ent.*, vol. xi, p. 162).—Length 8mm. Black; head golden, facial depression silvery, space between the eyes and the frontal stripe about

a variety of the common European *S. carnaria* it seems best to maintain it as a distinct species in accordance with the characters given by Mr. R. H. Meade, who, in his "Monograph upon the British species of *Sarcophaga* or Flesh-fly" (*Ent. Mo. Mag.*, vol. xii, p. 216 ff., Febr.-May, 1876), separates the species into two principal divisions, according as the tip of the abdomen is red or is black or gray. In a note published in Baron Osten Sacken's Catalogue of the Described Diptera of N. A., 2d ed., p. 257, Mr. Meade says: "There is no specimen in your collection, however, exactly like the true *S. carnaria* so common in Europe. There are some striking points of difference between the *Sarcophaga* of America and Europe generally, the chief of which is that in the former species with one or both anal segments red or yellow predominate, while among the latter, those with the anal segments black or gray are more numerous than those with the red."

The following additional specific characters may be added: Thorax with four bristles behind the suture in the two dorsal rows, the two anterior bristles small, the two posterior strong; in front of the suture are two small bristles alternating with two of slightly larger size. There are no minute spines on the second longitudinal vein similar to those on the fourth. The posterior tibiæ of the ♂ are loosely bearded on the inner side with long soft hairs. The second abdominal joint is not armed with strong central spines, and the spines at the apex of the third joint are short and weak.

equal to the breadth of the stripe, bristles of the head black, the pubescence behind and beneath the eyes white; antennæ blackish, palpi testaceous. Eyes at a moderate distance apart, thinly pubescent; front moderately prominent; third joint of the antennæ three or four times the length of the second joint. Thorax and the second and following abdominal joints more or less ashy, the thorax with four or five longitudinal black stripes. Wings subhyaline. Legs black, with a piceous tinge; tarsal cushions yellowish. Scutellum and the sides of the first, second, and third abdominal joints sometimes tinged with reddish-brown. No strong bristles on the first and second abdominal joints above.

A second species belonging to this genus has been bred from *Aletia* the past summer by Professor Comstock and referred to me, and others will doubtless be discovered. The reader interested in the minute differences that separate the maggots of these two genera, *Sarcophaga* and *Tachina* which similarly affect the Cotton Worm, is referred to the following comparisons:

The Tachinid larva differs from that of *Sarcophaga* in the following characters: It is of a paler whitish color, the skin being softer or less chitinated; the body is less narrowed anteriorly; the prothoracic spiracles are less apparent; a pair of spiracles are present on the posterior border of the fourth joint behind the head, which are not discoverable in *Sarcophaga*; the joints are not conspicuously wrinkled transversely and there are no lateral prominences, the anterior portion of each joint being prominent and roughened with minute points; the spiracular cavity at the end of the body is more shallow, the spiracles being exposed upon the obliquely truncated area; and there are no anal prolegs. The Tachinid puparium may be readily distinguished from that of *Sarcophaga* by the obsolescence (or in some species entire absence) of the prothoracic spiracles so prominent in *Sarcophaga*, and the absence of a cavity for the anal spiracles, both ends of the body being quite uniformly rounded.

Barthélemy has described the larva of *Senometopia atropivora* (*Ann. Sc. Nat.* 4^e ser., vii, p. 115), while Laboulbène has described both larva and pupa of *Tachina villica* (*Ann. Soc. Ent. Fr.*, 1851, p. 231, pl. 7); but as these descriptions are not readily accessible to the American reader, I reproduce from the *Trans. St. Louis Ac. Sc.*, vol. iii, p. 238 1-9 my description of the larva and pupa of *Sarcophaga sarracenæ*, and add for comparison that of *Beloisia bifasciata* (Fab.), one of our largest and most beautiful species, parasitic on *Citheronia regalis* and various species of *Dryocampa*.

SARCOPHAGA SARRACENÆ.—*Larva*—0.30–0.85 inch long. Body composed of but 11 visible joints exclusive of the head; microscopically and transversely shagreened; transversely wrinkled, the hind wrinkle on each joint more particularly prominent laterally. Head extremely small, or $\frac{1}{4}$ as large as joint 1, showing a division into two maxillary lobes at the tip and a larger labial lobe beneath, with a small bunch of setous fibres issuing from it; the black retractile jaws, of the ordinary form, issuing between these lobes, and the antennæ showing in two small rufous projections above the maxillary lobes; sparsely armed anteriorly with minute conical, sharp-pointed spines, decurved in front, directed backward beneath. Prothoracic spiracle pale rufous, retractile, sponge-like, studded with numerous lobules, divided at the end into a variable number of branches (6 being usually apparent, never more than 8), which in their turn ramify into lobules. Anal stigmatic cavity quite deep; the fleshy prominences on the carina surrounding it, sub-obsolete; the stigmata but slightly excavated below, the border brown, inclosing three brown openings, the lower ends of which reach to a circular clear space in the corneous and pale rufous peritreme. Anal prolegs quite small, with the longitudinal anal slit between, and a corneous plate in front of them.

Puparium—0.25–0.50 inch long; neither smooth nor highly polished, and varying from yellowish-brown to deep brown-black in color. Insections more or less distinctly traceable. Head and prothoracic joint retracted; the prothoracic spiracles protruding and forming two small ears about as long as joint 2; the mass of lobules hardened and rufous. Joints 2 and 3 constricted and flattened; 4 suddenly bulging. End of body squarely docked by spiracular cavity, the rim of which forms quite a ridge.

BELVOISIA BIFASCIATA.—*Larva*.—Length 15^{mm}. White, the skin soft; body cylindrical, tapering on the anterior joints towards the head, the apex obliquely truncated. Head small, furnished with two stout black hooks, situated under two crescentic elevations at a moderate distance apart; when viewed from in front the head obscurely bilobed, near the center of each lobe two chitinous points, one situated above the other. No prothoracic spiracles apparent, a distinct circular spiracle on the posterior border of the fourth joint behind the head, and situated slightly above the median line. The anterior border of each joint slightly prominent and, except on the dorsal side of the apical joints, roughened with minute points, the posterior border of the apical joints similarly roughened. Joints 4-11 with a distinct transverse median depression on the ventral side, the depression deepest on the intermediate joints, the portion behind this depression on the joint 11 forming a prominent transverse tubercle beneath the truncation, upon which the anal spiracles are situated. Anal spiracles black, each with the slit-like openings, and a circular spot in a clear space beneath them.

In Westwood's Introduction, vol. ii, fig. 131, ₂₀ is copied from Bouché, a figure of the larva of *Tachina concinnata* of similar form to that of *Belvoisia*; but the peculiar "prothoracic spiracle" figured in connection is not apparent in the larva before me. In the normal form of the Tachinid puparium the anterior pair of spiracular openings are even with the general surface of the puparium, so as to be discoverable with difficulty. The true spiracles are internal, and may be found opposite these perforations on the membrane which lines the puparium after the fly has escaped. The puparium is reddish-brown, the anal spiracles and the anus black; the joint of the body not distinct; the anal spiracles distinctly upon the surface of the subtruncated posterior end, not situated in a cavity as in *Sarcophaga*; just beneath these spiracles is a slight transverse elevation.

The puparium of *Belvoisia bifasciata* differs somewhat from the ordinary form. It is black, roughened, increases in width posteriorly, has the anal spiracles drawn far forward upon the back, and each represented by three swollen tubercles, and the space between them and the tip of the puparium is very irregular and has a conspicuous transverse depression.

Issuing from the Chrysalis.—The foregoing species issue in the larva or maggot state mostly from the worm and undergo their transformations independently of their host. All the other parasites yet to be mentioned undergo their transformations within the chrysalis and gnaw their way out of the more or less completely emptied shell as perfect insects. The Aletia is attacked, however, in the larva state, the parent parasite stinging and laying her eggs beneath the skin of the worm, and the parasitic larvæ affecting the vital parts only after the transformation of the victim to the chrysalis state. Whether or not any of the species here mentioned are secondary parasites will be considered in the final report; at present there is reason to believe that they are all primary.

THE DEVOURING CIRROSPILUS.—The chrysalides of Aletia formed during the latter part of the season are frequently infested with this little parasite, each chrysalis nourishing a number, which eat their way through the shell in the form of small black flies. This parasite is generally distributed, having been found by myself and Professor Willet in Georgia, and by Mr. Schwarz in Texas. The larvæ are pale elongate, egg-like maggots, and the flies issue all through the autumn, during mild winter weather and (the later ones) in spring. It belongs to the family *Chalcididae*, the insects of which are distinguished by their

parasitic habits, small size, metallic colors, veinless wings, thickened hind thighs, and by the pupa being formed without a cocoon.

2. *CIRROSPILUS ESURUS* Riley (Can. Ent., vol. xi, p. 162).—Length 1.5mm. Dull black; knees, tibiæ, and tarsi yellowish; the posterior tibiæ sometimes dusky. Eyes with scattered short bristles. Antennæ of the ♂ 9-jointed, with the joints of the flagellum subequal and beset with bristles, the ninth joint small. Antennæ of the ♀ 8-jointed, the fourth and fifth shorter than the second and third, the three apical joints forming a club. Thorax above microscopically punctate; parapsides distinct and elevated; scutellum with a longitudinal impressed line on each side. Wings hyaline, pubescent, but the cilia short; base of ulna uneven; radius not developed. Abdomen short and sessile; ovate.

This species shows relationship with the genus *Tetrastichus* Haliday, and may ultimately be referred there. For the present I prefer to place it in the older genus.

THE OVATE CHALCIS—A second species belonging to the same family as the preceding has similar habits, but being much larger issues in fewer numbers, and as a general thing singly, from the chrysalis. It is a black fly (*Chalcis ovata* Say,) with the greatly swollen hind thighs characteristic of the genus, and by means of which these insects are able to jump with great vigor. The species may be easily recognized by the posterior thighs being black with a yellow spot at the tip and by the tegulæ being entirely yellow. From the allied genus *Smicra*, with which *Chalcis* agrees in the swollen hind thighs, it may be distinguished by the sessile abdomen.

The larva is a slender legless maggot 7mm. in length. The body tapers at each end, particularly behind, and has a conspicuous lateral ridge. The head is similar to that of the *Pimpla* larva described further on, but the mandibles are nearly concealed, being covered by the other mouth parts. The first three joints of the body are separated by deeper constrictions than the succeeding joints, and the lateral tubercles on joints 4-10 have a smaller but distinct tubercle behind them. The spiracles in the alcoholic specimen are indistinct, owing to their agreeing with the skin in color; but their position is apparent upon the anterior border of the second, third, fourth, and several of the posterior joints. Length, 7mm.

The pupa is short and robust; pale at first but becoming brown, the head and thorax anteriorly darker. It has two prominent tubercles between the eyes just above the insertion of the antennæ, and above each of these a slight ridge extending as high as the lower ocellus, which is situated on a slight prominence within the fork of an impressed line on the vertex. Only five distinct joints in the antennæ between the scape and the club. Posterior femora larger than the wing-pads and slightly overlapped by them, posterior tarsi not extending to the tip of the abdomen. Tip of the abdomen narrowed and ending in a small truncated square.

The species is widespread in the United States and occurs also in Mexico and the West Indies. I have reared it from *Aletia* chrysalides collected by Professor Willet in Georgia, Professor Comstock in Alabama, Mr. Schwarz in Texas, Dr. Anderson in Mississippi, and myself in the first-mentioned State and in North Carolina; while I have likewise reared it from *Desmia maculalis* (the Grape leaf-folder), in Missouri, and found it commonly infesting the chrysalides of certain Hackberry-feeding worms (*Apatura Lycaon*, Fabr., and *A. Herse*, F.) in several of the Southern States.

Still a third of these smaller Hymenopterous parasites issuing in numbers from the *Aletia* chrysalis was obtained the past summer, and referred to me for determination by Professor Comstock. It belongs to an allied family (*Proctotrupidæ*), in which, as compared with the *Chalcididæ*, the body is generally longer, the antennæ also longer, the colors more sober, the wings have a few veins, the hind thighs are not fitted for jumping, and the pupa is usually formed in a cocoon. The species under consideration approaches the genus *Basalys* of Westwood, and I append a description of it:

*DICTIYUM** nov. gen.—*Head* transverse; three ocelli, approximate and triangularly arranged; labial palpi 3-jointed; antennæ inserted in front and close together: in the ♀ hardly reaching to the abdomen, 13-jointed, the two basal joints stout; joints 3-7 suddenly narrowed and together not much longer than 1 and 2; 3 being twice as long as the others; 8-13 twice as stout, peduncled, subequal in length, very slightly narrowing toward tip: in the ♂ as long as body, 15-jointed, joint 3 twice as long as any of the others, 4-15 subequal in length. *Thorax* as long as abdomen, slightly wider in the middle than the head; scutellum prominently raised, subovate and marginally ridged; legs with the tarsi uniformly 5-jointed; front wings without stigma, but with the veins forming with the costa two closed cells; hind wings with a stout costal vein, reaching and broadening to basal third of wing, where it is suddenly bent upward. *Abdomen* narrower than thorax, with a short peduncle.

D. zigzag, n. sp.—Average length 1.6mm. Body uniformly polished black. Legs, palpi, and antennæ reddish in female; coxæ, femora, and antennæ toward tip infusate in the male. Peduncled joints of antennæ with a few minute spines around the crown and longitudinally striate. Base of thorax and of abdomen with pale pubescent hairs. Wings hyaline, sparsely beset with minute spines which increase radially and form a fringe around the posterior half; the veins of front wings forming a sprawling W with partial cross veins proceeding from the lower angles, the basal cross vein longest; the longitudinal veins with a few prominent spines. Abdomen, ♀, showing but 4 joints, the terminal three short and hardly distinguishable ventrally.

The genus is readily distinguished, by the character of the venation and the structure of the antennæ, from *Basalys* Westwood, with which it has some affinity.

We next have certain larger, true Ichneumon-flies (*Ichneumonidæ*), of which but one specimen succeeds in maturing and issuing from the *Aletia* chrysalis, though more sometimes hatch within the worm, the others being eventually destroyed by the more successful rival.

THE WATCHFUL PIMPLA.—This species (*Pimpla conquisitor*, Say†), sometimes destroys from fifteen to twenty per cent. of the last brood of *Aletia*, and the chrysalides that are whole and that appear sound or alive after a good frost are found to contain its larva or pupa in still greater proportion. It has been obtained from *Aletia* from all parts of the South, and by most of the observers and agents of the Commission, the fly issuing sometimes in the Fall, but mostly in spring. It is a black, four-winged fly, varying in length from one-fourth to one-half of an inch, and may be

* Δίς double; δίκτυον, net.

† *Cryptus conquisitor*, Say, Bost. Jour., i, 232, of which, as Walsh, (Canadian Entomologist, ii, 12,) pointed out, *Cryptus pleurivinctus*, Say, l. c., 235, is a synonym. By some oversight *pleurivinctus* stands as a synonym under *annulicornis*, Cress., instead of *conquisitor* in Mr. Cresson's List of the North American *Pimplariæ*, (Trans. Am. Ent. Soc., iii, 170.)

distinguished from other native species of the genus *Pimpla* by having the margins of the abdominal segments white. The exerted ovipositor does not exceed one-half the length of the abdomen, and the male may be recognized by the absence of an ovipositor and by his more slender body. Say reared the species from a follicle of a case-bearing Bombycid moth with transparent wings, probably the common Bag Worm (*Thyridopteryx ephemeraeformis*, Haw.*).

The larva of *Pimpla conquisitor* is a legless maggot of a whitish color, the head well defined, concolorous with the body and with distinct mouth parts; the tips of the mandibles black. The body tapers posteriorly, the skin is finely wrinkled and no spiracles are apparent; the first three joints have a longitudinal, impressed line low down on the sides, and the succeeding joints have a similar line higher up, and above it a distinct lateral ridge or series of protuberances. The mandibles are slender and pointed, situated beneath the labrum and above the three fleshy tubercles which represent the maxillæ and labrum. Above the labrum are two distant and very indistinct circles with a minute point in the center, indicating the position of the antennæ. The largest larva examined measured 9^{mm}.

The pupa resembles the imago in the form of body, but the colors are undeveloped, the wings unexpanded, and the legs, antennæ, and palpi laid along the sides and breast. In the ♂ the tip of the abdomen is abruptly terminated and just before the tip on each side is a tubercle bearing two projecting teeth; in the ♀ the ovipositor is curved up over the back.

The species is widely distributed over the United States and attacks a large number of other Lepidopterous larvæ. It is probably the most effectual as it is the most noticeable check to Aletia, and that it has always attacked it seems most probable; for the following account by Dr. Gorham, published in 1852 in the article in De Bow's Industrial Resources, etc. (p. 168), already cited, gives such an exact account of it, and such a full general description, that, while he could not name it, there is no question as to its identity with the species under consideration. In endeavoring to explain the disappearance of the Cotton Worm in early winter, Dr. Gorham writes:†

* * * Let us take a pocketful of these [the chrysalides] home and place them beneath tumbler, and wait patiently to see what they will produce. * * * About the fifteenth of November the insect appeared, but, *mirabile dictu!* as different from the Cotton fly as it is possible to suppose one insect could differ from another. It belonged altogether to a different family, a description of which I give as follows:

Antennæ filiform; black, six lines in length. Palpi four, two external and two intermediate, the external white, twice the length of the other two, in shape angular, the angles projecting externally. The two middle are straight, scarcely perceptible over a strong light; they are of a dark color. Wings four; hymenopterous; incumbent, extending to and exactly even with the end of the tail; shape of the wings, which are small and extremely delicate, like that of a fan. Front legs half the length of the posterior, of a uniform orange color; the intermediate legs very little longer than the anterior; the thighs of a deep orange color, the rest of the leg annulated with

* In the Trans. St. Louis Acad. Sci., iii, 137, a detailed description of *conquisitor* is given by Mr. Walsh, who there identified Say's *Bombyx* with *Clisiocampa americana*; but this determination is not in accord with Say's account of the moth.

† Dr. Phares refers to Dr. Gorham's experience with this parasite in his excellent article published in the *Rural Carolinian* for August, 1870 (vol. i, p. 689), but only in order to criticize some of Dr. Gorham's deductions, and not to confirm its occurrence by his own experience.

orange and white. The posterior legs long in comparison to the others; thighs of a deep orange color, the rest of the leg annulated with black and white, the rings being larger than those of the intermediate. The trunk is of a uniform shining black, as would be the upper surface of the abdomen also were it not for the very narrow white bands which connect the black scales together, giving to the abdomen an annulated appearance; these white lines do not encircle the abdomen, but terminate uniformly on the sides. On the under surface of the abdomen these white rings again commence, which are larger than those on the upper surface, causing the abdomen to look almost white. The tail terminates in a bifurcated sheath, inclosing a long blunt sting, projecting considerably beyond the tail, and forming a very prominent feature in the general figure of the insect. This is a small, slender insect, much longer than the honey bee, but not so thick.

Three years later what is evidently the same species is referred to again without name by Mr. Glover, who says: * "Some chrysalides of the cotton caterpillar, which had been preserved during the summer of 1855, as an experiment to try whether they would live until the following spring, having been hatched prematurely by the heat of the room in which they were kept, two *Ichneumon*-flies were produced of a slender shape, and about half an inch in length; the abdomen or body of the female was black, and marked with seven light-colored, yellowish, narrow rings around it," etc. In the *Agricultural Report* for 1867 (p. 61) his remarks that the cotton caterpillar is destroyed by a "small yellow and black banded ichneumon-fly" probably refer to the same species.



FIG. 27.—*PIMPLA ANNULIPES*: outline side view of female and of male abdomen. (After Riley.)

THE RING-LEGGED PIMPLA.—This is another species (*Pimpla annulipes* Br., Fig. 27) of the same genus, having about the same size and general appearance, but having the rings on the abdomen dusky or reddish instead of whitish, and differing in other minute particulars. It is less numerous than the preceding, but I have obtained it from chrysalides sent by Dr. Anderson, and received it the past summer from Professor Comstock as reared from *Aletia*. In habit it is precisely like *conquisitor*, and equally widespread and destructive to other species of *Lepidoptera*,† being one of the few parasites of the common Apple Worm (*Carpocapsa pomonella*).

CRYPTUS NUNCIUS.—A third *Ichneumon*-fly belonging to a different genus and having similar habits with the *Pimplas* just described, except that the pupa is formed in a cocoon, may (considering the known variability of coloration in the species of the genus) be referred to *Cryptus nunci*us, Say. It is a black and red, four-winged fly with transparent wings, and issues from the *Aletia* chrysalis during the spring. It is a well-known parasite of our large native silkworms, *Attacus promethea*,

* Patent Office Report 1855 (Agriculture), p. 111.

† See Mo. Ent. Repts., iv, p. 43; v, p. 49.

A. cecropia, and *A. polyphemus*, from the cocoons of which it emerges in the Northern States early in the spring, a considerable number of the parasite appearing from a single cocoon.

A female specimen from *Aletia* has the head and thorax black, the 8th-10th joints of the antennæ white, the palpi black, the legs including all the coxæ red, with the tips of the posterior femora and of the posterior tibiæ black, and the posterior tarsi tinged with brown. The first four joints of the abdomen are entirely red, the succeeding joints and the sheaths of the ovipositor black, the ovipositor itself reddish; the apical joints of the abdomen have a white spot above. Relying upon the length of the ovipositor as a character for separating *nuncius*, Say, from *samiæ*, Pack.,* the female of the present species may be distinguished by the ovipositor being much shorter than the abdomen, as shown in Fig. 28, *b*; Fig. 28, *a* representing *Cryptus samiæ*. Fig. 28, *c* indicates the form of the abdomen in the male.

We thus have ten distinct parasites actually observed to infest *Aletia*, and issuing either from the egg (1 species), from the larvæ (3 species), or from the chrysalis (6 species), and belonging to two orders and four families. A yet unbred species (doubtless subf. *Braconides*) that destroys the young worm, its larvæ issuing from the back of their victim and there forming loose cocoons in company was sent me from Alabama by Professor Comstock; while Mr. Glover has figured, in the Patent Office report for 1855, just cited (Pl. X, Fig. 4), what is evidently a parasite belonging to the true genus *Ichneumon*, which he found in cotton fields near Columbus, Ga., "busily employed in search of some caterpillars."

Aletia may truly be said, therefore, to have its full share of parasitic checks, and the number will, without much doubt, be increased by future observation.

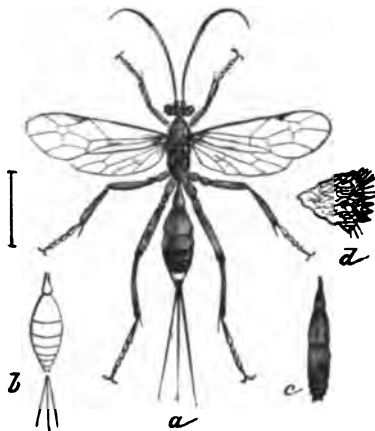


FIG. 28.—*CRYPTUS NUNCIUS*: *a*, female; *b*, female abdomen of *C. samiæ*; *c*, male abdomen; *d*, highly magnified piece of wing-hair-line showing natural length. (After Riley.)

12. REMEDIES: MEANS OF COPING WITH THE INSECT.

For the present purpose these may be considered under the several heads of [1] Prevention; [2] Mechanical Means of Killing the Worms; [3] Poisoning the Worms; and [4] Destruction of the Moth.

In treating of the various machines, contrivances, and compounds that have been used for the destruction of this insect, it is my endeavor to bring to the notice of the planter all those that are worthy of mention; to point out their advantages and disadvantages; wherein they are susceptible of improvement; and how they may be used most economically

* The name *Cryptus extrematis*, Cross. should yield to *C. samiæ*, Pack., because of two species (one of which is *nuncius*) were combined under it in the original description.

and effectively. The planter can then judge for himself which he can most profitably adopt, according as his own circumstances dictate. In doing this, some of the earlier machines and contrivances, though now superseded by improved ones, will be enumerated, because they are of interest from an historical point of view, as showing what has been done by the inventive genius of the South in contending, and by no means unsuccessfully, against this pest.

From the variety of the inventions and the ingenuity displayed in many of them, it will be seen that, in this instance, the energy and enterprise of the southern planter compare favorably with that shown by cultivators of the soil in other sections of the country in contending with other destructive insects.

A survey of the whole subject brings out prominently two important facts that should be emphasized.

First. Though, as we have already seen (p. 8), there is every reason to believe that the ravages of the worm were proportionally as great before as they have been since the late war, yet all the more important inventions post-date that period. Prior thereto only the more primitive and ineffective means of destruction, such as hand-picking and the use of fires and lights in the fields at night, were resorted to.

Secondly, by far the greater number of the machines have been invented in Texas, a fact which corroborates previous statements that the worm occurs more regularly and more disastrously there than in other States. Both facts are indicative of the more healthy development of the South under free as compared with slave labor.

PREVENTION.

That much can be done toward preventing the ravages of this worm there is no question. The mode of cultivation has some influence; the principal object should be to hasten maturity so that a portion of the crop shall be beyond the reach of harm from the more disastrous July and August broods. Aside from careful and frequent cultivation, which, moreover, has a tendency to disturb and knock off the worms, early planting in this connection is to be urged, though of course it has its drawback in exceptional seasons in the risk of late frosts. The use of early maturing varieties and of cotton seed obtained from more northern regions will also help to defeat the enemy, while it has long been known that some varieties are less subject to attack than others—the long-staple being much more injured, for instance, than short-staple when planted side by side. Topping the cotton, while it would have very little effect in the early part of the season, may be employed to good advantage later, in cases where desperate means and the loss of the top crop are warranted. The frequent exemption of small fields that are separated from larger ones or surrounded by some other crop is noticeable and suggestive in this connection, while it will always be well to avoid planting

cotton in those spots where the worms have been known to first reappear year after year. Diversified agriculture, and the rotation of crops on the same field are most desirable in this connection.

The protection of those natural enemies of the worm that permit of it should not be neglected, and all shooting and trapping of the smaller birds prohibited, while the killing of hawks and other birds of prey should be encouraged. Tame fowls, such as chickens, turkeys, and Guinea-hens will prove valuable, especially if brought up near those spots where the first worms occur. The leaving of an occasional tree in fields in an open country, or even old stumps, while it may be looked upon by some as thriftless agriculture, is nevertheless advisable, for the immunity of fields containing such is often noticeable. Some attribute this immunity to the shade afforded by the trees, but the real explanation is more probably to be found in the protection they offer to birds and ants. These last, more particularly, are less liable to be washed away and destroyed by heavy rains at points where trees and stumps occur. The importance of the destruction of the first moths, whether by lights or poisons, will be shown farther on, while that of the killing of the first worms is too apparent to need enforcing. The fact that vast numbers of late chrysalides are carried into the gin house, and that the moths issuing therefrom are so likely to find the requisite winter protection there, points to the expediency of removing and destroying those chrysalides as soon as possible and not allowing them to remain in the gin house until they hatch.

Dr. Phares has suggested that by systematically deferring the planting of cotton till the end of May, or until all the hibernating moths had perished without finding food for their issue, and then planting some early maturing variety, we might entirely prevent the injuries of the worm. This would be an excellent suggestion could the planter know beforehand that it would be necessary, and were there not decided advantages, as just set forth, in getting early maturity.

I will not discuss here the effects of interspersing or surrounding the cotton with corn, as is so often practiced in the South; for while it may have some effect in lessening the Cotton Worm, there is not yet sufficient confirmation of the fact, and the custom doubtless helps to increase the injury from the Boll Worm.

Finally jute (*Corchorus capsularis*) sown around a cotton field or in spaces between the rows has been strongly recommended by Mr. J. Curtis Waldo, of New Orleans, as a preventive, the recommendation being ostensibly based on observation. None of the correspondents of the Commission have given any corroborative experience in answer to the direct question on this subject contained in our circular. Its effects I hope to test another season.

MECHANICAL MEANS OF KILLING THE WORMS.

During very hot, clear weather, much good may be accomplished by knocking down or brushing the worms from the plants on to the ground

and crushing or killing them in various ways. One of the best methods of doing this is, in the words of Dr. J. D. Hoyt, of Livingston, Ala.,* "to drag something like a piece of cotton bagging along over the rows of cotton, forward and back; which may be long enough to extend across several rows, and having short lines attached to one edge, a little further apart than the width of the rows, and a hand at each line, and all abreast pass along between the rows, and then back; when the brushing and shaking of the stalks by the bagging will clear the cotton mostly of the worms. In this way, a set of hands can go over their crop in a day or two; when they should return to the beginning and go over again; and continue so doing as long as any number of worms are found on the stalks."

A number of machines have been invented to expedite these mechanical means of destroying the Colorado potato-beetle and other leaf-feeding insects, and a few of similar character have been especially contrived for the Cotton Worm. They will hardly come into general use for the simple reason that, under ordinary circumstances, they are more expensive and less satisfactory than the methods of poisoning. But as many persons are opposed to the use of poisons and prefer to resort to other modes of destruction, even when more expensive, we shall give an account of the more useful ones.

Machine for brushing off the Worms.

THE EWING BRUSHING-MACHINE.—One of the earliest-used machines

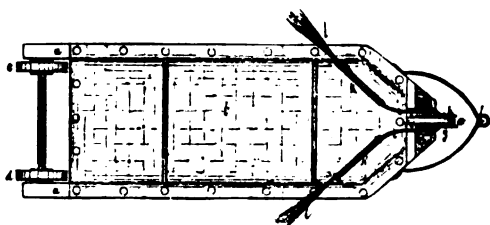


FIG. 29.—EWING BRUSHING-MACHINE: Top view.

of this kind is that invented by Mr. William Ewing, of Columbia, La., in 1869. Starting from the observation that the worms drop or throw themselves from the plant upon moderate disturbance of the leaves and branches,

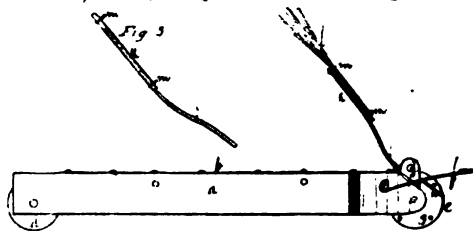


FIG. 30.—EWING BRUSHING-MACHINE: Side view.

Mr. Ewing constructed a very simple machine, of which Fig. 29 represents a top view and Fig. 30 a side view. In these drawings *a* represents a frame constructed of wood or other suitable material, *c d e* the wheels, and *f* a yoke or drawing device. Upon the front wheel *e*, on

either side, are pins *g* which act upon the lower ends *h* of the arms *i* as the wheel is rotated. These arms are pivoted to plates *j*, and extend upward and outward so as to pass along the sides and over the top of the plants. To the upper part of these arms other tubular arms *k* are affixed, so that the

brushes *l*, secured thereto and held in place by eyes or rings *m*, may be adjusted to the height of the plants. Between the frame a canvas, *b*, is stretched. This latter is smeared with tar or any other material to which the worms will stick or adhere for a reasonable length of time.

This machine is intended to be drawn by hand, or by a horse or mule, between two rows of plants, the leaves and branches of which are agitated by the arms and brushes. The worms fall upon the smeared surface of the canvas, and may easily be gathered up and destroyed. It is evident, however, that only those worms are caught which fall toward the inside of the rows of plants between which the machine passes. To obviate this drawback, Mr. Ewing suggests the attaching to each side of the frame another light frame of wire rods or cane, reaching above the tops of the plants, thence down again to near the ground, and there carrying a canvas which is likewise smeared with tar.

THE HELM BRUSHING-MACHINE.—Another machine for the same purpose was invented by Mr. J. Helm, of Hochheim, Tex., in 1873. It consists of a movable frame, drawn by animals over the fields, to straddle, with brushes made of split white oak or other suitable material, the leaves and branches of a row of cotton-plants, and to kill the dislodged worms on the ground by means of jointed bottom pieces or slides. In the accompanying outlines Fig. 31 represents a side elevation of this machine; Fig. 32 a vertical transverse section of the lower part of the same taken on the plane of the line *c c* of Fig. 31; and Fig. 33 is a vertical transverse section on the line *k k* of Fig. 31.

In the accompanying drawing, the letter *A* represents a frame composed of two bottom boards, *a a*, of four or more uprights, *b b*, and a suitable series of cross-braces, *d d*. The boards *a a* are on a level and parallel to each other, and have wings *e e* and *f f* hinged to their inner and outer edges, respectively. To each of the front parts *b* is pivoted, at *g*, a lever, *B*, which carries a wheel, *C*, at its front end. There are thus two such wheels *C C* that rest on the ground in front of the apparatus. Draft-hooks *h h* are applied to the front ends of the levers *B* for hitching the draft animals to, by which the machine is drawn over the field. The levers *B* can be swung on their pivots to raise the frame *A* on the wheels *C* whenever stones, stumps, or other obstructions are to be avoided. In such case the

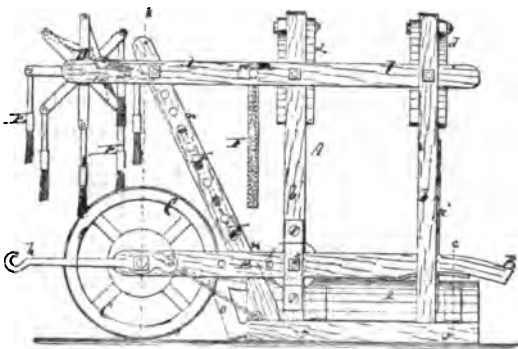


FIG. 31.—HELM BRUSHING-MACHINE: side view.



FIG. 32.—HELM BRUSHING-MACHINE: transverse section of lower part.

levers *B* are or can be locked to toothed plates *i*, which are applied to the rear posts *b*, as indicated in Fig. 31. When the machine is to be turned it is also necessary to

elevate the frame A off the ground, and throw the whole weight of the apparatus upon the wheels C. Whenever the frame A is thus raised the wings *e* and *f* will be swung up to clear the upper expanded parts of the cotton plants. This is done by connecting the two wings that are hinged to each board *a* with each other by a string, *j*,

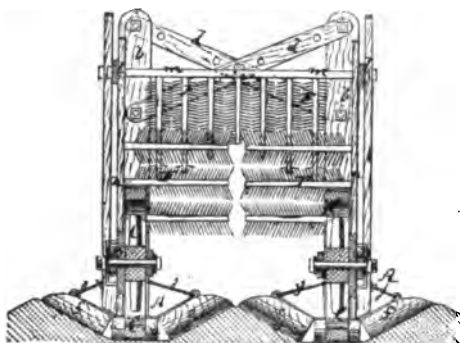


FIG. 33.—HELM BRUSHING-MACHINE: transverse section.

For use, the machine is placed to straddle a row of cotton between the inner wings *ee*. The boards *aa* rest in the furrows and the outer wings on the rising sides of the adjoining ridges, all as clearly shown in Fig. 2. The wings rest with their weight on the sides of the ridges. The machine being drawn ahead, the shaft D is revolved by its brushes E, which come in contact with the cotton plants. Also, by subsequent contact with the brushes FF, the worms are all swept to the ground, on which they are finally crushed and destroyed by the weight of the boards *a* and wings *ef*.

Apart from the circumstance that this machine straddles only one row of plants, it is extremely doubtful whether all, or even a large portion of the worms would be crushed by the bottom pieces, considering the uneven nature of the ground.

Two other machines, though originally intended for clearing potato-vines of their insect enemies, deserve notice here.

THE WOOD-SMITH BRUSHING-MACHINE.—The first of these was

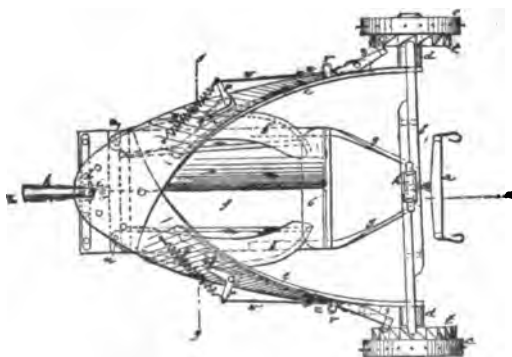


Fig. 34.—WOOD-SMITH BRUSHING-MACHINE: from above.

from which they cannot escape. The parts of the apparatus are adjustable to suit the height of the plants.

In the accompanying drawings, Fig. 34 is a plan of the apparatus.

Fig. 35 is a longitudinal section at the line *x x*. Fig. 36 is a cross-section at the line *y y*.

Similar letters of reference indicate corresponding parts. *a a* are vertical standards, connected together by a cross-bar, *b*, at their upper ends. *c c* are wheels mounted on short axles fitted in the boxes *d*, at the lower ends of standards *a*.

The standards *a* are at such a distance apart that the wheels *c* will run between the rows of plants and two rows of plants be between the wheels.

The cross-bar *b* is made in two pieces, as shown, connected together by screws, so that the bar can be adjusted according to the width of the rows. *e e* are wings, one at each side of the apparatus. The forward ends of the wings are attached to the standards *a*, and their rear ends are connected together at the center line of the machine. These wings *e* are of suitable width, and they are attached

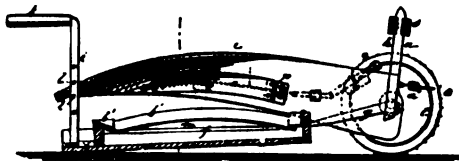


Fig. 35. - WOOD-SMITH BRUSHING-MACHINE: longitudinal section.

with their edges vertical at the forward end, and are twisted *e*, as to lie flat where they are connected together at the rear end. *f* is a pan-shaped receptacle, attached by arms *g* to a bar, *h*, that is suspended from bar *b*, midway between the wheels *c*. *i* is a vertical rod rising from the rear end of the receptacle *f*, and passing through a hole in the ends of wings *e*.

The upper end of rod *i* is provided with a handle, *k*, by which the rear end of the machine may be managed. There are holes in rod *i* into which pins *l l* may be inserted to retain the rear ends of the wings *e* at the desired height, according to the growth of the plants. The strips *m* that form the sides of the receptacle *f* are pivoted by pins *n* at one end, so that the receptacle can be made wider or the reverse, according to the width of the rows.

At the inner side of the wings *e*, and projecting over the receptacle, are flappers *o o*, hinged at *p*. Each of these flappers has a rod, *q*, passing through the wing that the

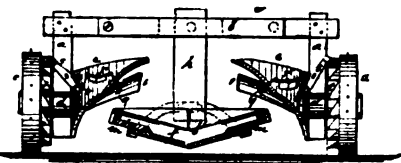


Fig. 36. - WOOD-SMITH MACHINE: cross-section.

flapper is hinged to, and connected with a crank-lever, *r*, hung at the outside of the wing. *s* is a lever fulcrumed at the forward end of the wing in such position that one end of the lever is acted upon by the teeth *t* attached to the inner side of the wheel *c*. The other end of the lever is connected by a strap, *u*, that passes beneath a roller, *v*, to a rod, *w*, that is attached to crank-lever *x*; *y* is a spring connected to lever *n* and to the wing *e*. The teeth *t* depress the lever *s* and draw upon the crank-lever *r* and spring *y* and draw the flapper outward; but as soon as the lever *s* clears the tooth the flapper springs out quickly. The arrangement is the same on both flappers *o*, and by that means a series of rapid blows are given upon plants gathered by the wings.

A horse is to be attached to the whiffletree *a'*, that is hung on bar *h*. The horse will walk between the rows of plants that are to be operated upon by the apparatus, and the receptacle *f* will run on the ground between the rows. As the apparatus is drawn forward the plants pass beneath the bar *b*, one row at each side of the bar *h* and pan *f*, and the rows will be gathered together and bent down beneath the wings. The flappers will shake the plant and the larvæ will be rubbed and shaken off into the receptacle.

THE ISKE BRUSHING-MACHINE.—This was invented by Mr. Anthony Iske, of Lancaster, Pa., in 1876.

It consists of an upright frame, open beneath, with two wheels in

front, and is drawn over one row of plants at a time. A row of brushes, made of broom-corn or of any other suitable material, is fastened to a longitudinal beam, which is adjustable to the height of the plants and agitated by a contrivance similar to that in Mr. Ewing's machine. The worms dislodged by the action of these brushes fall in two canoe-shaped trays, which are supported by swinging arms, and slide along one on each side of the row of plants close to their base. On the outer side of each, these trays are provided with a smooth inclining shelf, which dips into the tray, and with a vertical backboard in order to prevent any worms from being beaten beyond these trays. In using this machine it is necessary to smear the trays with tar or coal-oil.

Finally, having proved that the least touch of kerosene is as fatal to the Cotton Worm as it is to so many other insects, I have no hesitation in recommending as a cheap substitute for these brushing-machines, where youthful labor is abundant, the use of sheet-iron pans, over the bottom of which kerosene or coal-tar is spread. They proved very successful in 1877, when the Western farmers were contending with young locusts; and, drawn between the rows of cotton, while the worms are being brushed off in the manner recommended by Mr. Hoyt, they would prove equally satisfactory when the weather is not sufficiently hot and dry to insure the death of the worms otherwise. Or a still simpler arrangement might be adopted, viz: a cloth stretched on a frame that will draw between the rows and kept saturated with kerosene.

POISONING THE WORMS.

With the introduction of mineral poisons for the destruction of the worms a new impetus was given to the invention of machines and contrivances for the application of these poisons either as powder or in water. The large number of such inventions made during the past six years, and the activity still displayed in adding improvements, furnish evidence that this poisoning of the worms has so far proved most satisfactory in protecting the crop. The fact is that a judicious and timely application of the best poison will always, even under unfavorable conditions and in bad "worm years," enable the energetic planter to save at least the larger portion of his crop. There is no question but that concerted action in the application of poisons early in the season, in those counties in which the worms first appear, would not only effectually protect the crop in those counties at comparatively little cost and labor, but also prevent, or at any rate retard, the spread and migration of the moths into the rest of the cotton belt. There is little hope, however, of any such concert of action in the larger part of the cotton-growing country to-day, because where there is one planter who superintends the cultivation of his own land and is alive to the importance of such work, there are many cotton farms either rented or owned by freedmen who are usually ignorant and shiftless and with whom intelligent co-operation is almost, if not quite, impossible. Each planter must, therefore,

depend on his own efforts, and it is a satisfaction to know that these may be successful notwithstanding more careless neighbors.

There are certain general principles which I would here insist on that should govern the use of these poisons. It is very evident from the habits of the worms, as already detailed, that such poisons will prove most satisfactory if applied to the under side of the leaves when the worms first begin to appear in numbers. While poisons in solution can be applied at any time of the day during dry weather, those in powder are most advantageously applied in the early morning hours while yet the plants are moist with dew. The greater adhesiveness given to the poison the better. Those used in powder form are naturally the most effectual in rainy weather, during which, as we have seen, the worms are most injurious. These dry poisons have, further, the advantage for the small planter that they can be used with less extensive and expensive apparatus and with less labor than those in solution. Finally, too much stress cannot be laid on the importance of having the materials ready prepared in advance, or on their use as soon as the eggs or young worms are noticed. It is too often the habit to wait until the plants begin to be "ragged" before attempting to poison. The operation is always more costly and unsatisfactory at this period, and there is danger that, with the most strenuous efforts, irreparable damage will be done before all the cotton is gone over. It often happens also, since the same influences cause the multiplication of the worms over pretty large areas, that a sudden and general demand for the poisons by those who have not previously laid in a stock increases the price or exhausts the market, so that many are left without hope of saving their crop.

Arsenical Compounds.

Arsenical compounds have the acknowledged disadvantage of being dangerous to man and beast. Some writers, taking a most narrow and theoretical view of the subject, bitterly object to their use on the score of their dangerous character, exaggerating in their enthusiasm the injury that has resulted from their use. Not only hundreds of tons but thousands of tons of these mineral poisons have been employed during the past decade by farmers throughout the country, whether to protect the potato crop or the cotton crop or other products of the soil from the ruinous attacks of insects. The general experience during this long period and over the whole country is so emphatically in favor of their use and their perfect safety and harmlessness, with ordinary precautions, as to render almost laughable the objections of the few persons referred to. No advancement, no improvement, no general benefit to the human race is ever accomplished without some attendant danger, and those who inveigh against such improvements as increasing the risks to life stand on the same footing as the opponents to arsenical poisons as insecticides. It is a noteworthy fact that, since I have been pursuing this Cotton-insect investigation, not a single fatal case of human poisoning by the use of these minerals against the worm has come to my notice

from the South, notwithstanding they are often used in that section of the country with great recklessness. Nevertheless it is no uncommon thing to hear of partial poisoning among negroes, resulting from that indifference which comes from constant use, and the importance of care and caution cannot be too strongly urged, especially near towns or in thickly settled neighborhoods.* Most of these poisons can be applied to the leaves either in water or dry, but some of the compounds are prepared so as to be used only in the former manner.

It has been my principal ambition to discover some substitute for these poisons that shall be equally effectual, harmless to man, and cheaper. The experiments that have been carried on by the Commission with this object have been sufficiently encouraging, as the sequence will show; yet, for the reasons stated in the Introduction, they are by no means exhaustive, and there is every reason to hope for great improvement in this direction.

PARIS GREEN.—The nature and effects of this poison are now too well and generally known among planters to need consideration. Planters have too often found in its use a path leading from threatened ruin and bankruptcy to be much influenced by theoretical arguments against it. A study of its effects, based upon experience and experiment, whether upon the plant or upon the soil, shows that no harm results from its judicious use.† My expectations in first suggesting its use as a Cotton-Worm destroyer at the Saint Louis meeting of the National Agricultural Congress in 1872, and more confidently recommending it before the same body at Indianapolis in 1873, have been fully realized by the experience of the past seven years. Complaints of its inefficacy are readily traceable either to faulty application or the use of an adulterated article. Its principal disadvantages are its great cost, often increased by the exorbitant profits demanded by merchants, and the consequent temptation to adulterate or imitate the genuine article.‡ Another disadvantage is the difficulty of keeping it suspended in water, but this is easily overcome either by the employment of an additional hand to keep the water stirred up, or by adding to the various pumps with which the poison is distributed a simple self-acting lever inside of the barrel or other vessel containing it. This, together with the motion of the pump, is sufficient to prevent settlement. Its advantage over the other arsenical poisons, besides its undoubted efficacy, is that it is least liable to scald the leaves and to cause the young bolls to shed.

If used in liquid suspension, a simple mixing with water is sufficient in dry weather. If pure, one-half pound to 40 gallons will answer. One

* So long as such cases of poisoning are liable to occur it will be well to widely publish the means of counteracting the poison. The antidote most highly recommended and found in practice to be effectual is hydrated sesquioxide or peroxide of iron, which may be purchased at any drug store. A few spoonfuls taken soon after a case of poisoning will counteract any evil effects.

† A discussion of this subject will be found in a work by the writer entitled "Potato Pests," pp. 69-75.

‡ An easy way of testing the purity of Paris green is to put about 100 grains in an ordinary wine glass and add thereto an ounce of liquid ammonia. In proportion as there is little or no sediment the green may be considered pure.

pound to that quantity of water is more often used, and considered most satisfactory. This is sufficient for one acre of cotton, and the cost per acre of a single application, including labor, varies according to a number of circumstances, but ranges from 25 cents to 60 cents.* It pays to add two or three pounds of flour or starch to the mixture, not only because of the greater adhesiveness which they give to the poison (a very desirable object, especially in wet weather), but because, by their color, they help to indicate the quantity that has been distributed. In using flour it will be found advisable to mix it first in a bucketful of water and allow it to remain until it sours, the object being to prevent it from forming lumps.

When applied in powder the green must be mixed with other ingredients in order to render it sufficiently economical and avoid injury to the plants. These ingredients should be cheap and, as far as possible, adhesive. Of the various mixtures that are used to-day and that have come to my knowledge all may be considered good. The proportion of the green to the diluents should be as 1 to 25, though the mixture is often used stronger, or as 1 to 18. Flour, or plaster, or cotton-seed meal are used with equal success, or a combination of them, the proportion being immaterial. Finely-sifted wood ashes may also be used as a diluent, one of the most popular mixtures consisting of one pound of Paris green, 6 lbs. of wood ashes, and about 12 lbs. of flour. In all cases it is advisable to add a small proportion, say from one to two pounds to the above formula, of some finely-powdered material of still greater adhesive quality, as dextrine, or gum arabic, or slippery-elm bark, or rosin. The cost per acre of one application of the dry mixture varies from 50 cents to \$1.75, according to the first cost of materials and different modes of application, or, again, to the size of the plants at the time of the application.

Five patents have been issued for different combinations with Paris green. In 1868 Mr. J. P. Wilson, of Illinois, took out a patent (No. 82468) for one part of Paris green and two of mineral paint to be used to kill potato-bugs. In 1871 Mr. Lemuel Pugin, of Niles, Mich. (patent No. 112732), claimed a mixture (Paris green, 2 lbs.; rosin, 2½ lbs.; gum arabic or slippery-elm, ½ lb.; wheat flour, 5 lbs.; middlings, 1 bush.) for the same purpose. In 1873 Mr. G. F. Whisenant, of Chapel Hill, Texas, obtained a patent (No. 134959, Paris green, ¼ lb.; arsenic, 1 lb.; lime, 26 lbs.; and flour 5 lbs.) for destroying caterpillars on cotton. In the same year Mr. Wm. B. Royall, of Brenham, Texas, obtained patent for the same purpose (No. 140079, June 17, 1873), the ingredients being Paris green, 1 lb.; cobalt, 2 ozz.; flour, 17 lbs.; powdered gum tragacanth, 3 ozz.; powdered licorice root, 6 ozz.; and subsequently still another (No. 151439, May 26, 1874, Paris green, 1 lb.; flour, 4 lbs.; cotton-seed meal, 16 lbs.) for the substitution in part of cotton-seed meal for ordinary flour.

* The present year, Paris green averaged about 17 cents per pound in Selma, Ala., and 40 cents in Columbus, Tex.

Regarding these patent mixtures it must be borne in mind that the value of Paris green with some dilutent as an insecticide had been widely made public before any of them were issued, and I can but repeat here previously expressed opinion* that "it is to be regretted that patents can be obtained at all for remedies of this nature after they have become generally known and rightfully belong to the public. When the discoverer of such a remedy does not see fit to patent it, no one subsequently has a moral right to, whatever speculative right he may possess. Fortunately, in this case the patentees cannot interfere with the public rights, and it is to be hoped that no planter, either of potatoes or cotton, will be induced by flaming circulars and threats to pay even one cent per one thousand acres, much less the demanded \$20 per one hundred acres, for the privilege of using these patented mixtures. The very fact that so many patents have been granted for the same purpose, all of them having Paris green as a base, shows clearly that the patent covers only the particular combination. By ringing the changes on the different proportions of the several ingredients, a thousand of these patent remedies may be obtained; and any one who diverges but a fraction from the particular patented combination ceases to infringe upon it. It will therefore be utterly impossible for the patentees to enforce the penalty for infringement without proof that precisely the same ingredients and combination as patented were used; and to get such proof will, I take it, be no easy matter; for were it, we should hear of hundreds of thousands of prosecutions where now we hear not of a single one."

Experience has justified this advice, for, while immense sums have been paid by planters to some parties for the right to use Paris green mixtures, the patentees have been unable to get protection from the courts whenever they have sued for infringement in the independent use of them by planters. The letter of the law too often negatives the spirit of the law, and it seems that the Patent Office has been forced to issue the patents above alluded to on the ground and decision that any change in the compounds of a mixture makes of it, in law, a new substance.

ARSENIC.—While commercial arsenic, salts of arsenic, and the various compounds of them are much cheaper than Paris green, yet this advantage is more than counterbalanced by the injurious property they possess, in a more or less marked degree, of scalding the leaves and causing the squares and young bolls to shed. Moreover, on account of their white color there is more danger of injury to man and animals in their use than in that of colored preparations, which are less likely to be mistaken for harmless substances. Great care and precaution are, therefore, necessary in applying these arsenic poisons. When applied in just the right proportions to kill the worms without injuring the cotton they are valuable substitutes for the more expensive Paris green, but unfortu-

* Sixth Mo. Ent. Rep., 1873, p. 21.

nately these proportions vary with each particular combination, so that they can be satisfactorily ascertained only by absolute experiment. In fact, experience would indicate that it is almost impossible to use arsenic in any of the forms considered under this head without producing a bad effect upon the squares. It is for this reason that the Paris green mixtures have held their own against the cheaper compounds, and most planters, even where these last are used, find it desirable to still mix a certain proportion of the Green with them.

Commercial arsenic, costing from 7 to 10 cents per lb., is applied in powder form at the ratio of $\frac{1}{2}$ lb. to from 18 to 25 of any of the ingredients used with Paris green. Used in water, these arsenic compounds give less satisfaction because of the dangers to the plant already alluded to, which are then increased. It is an interesting fact that already in 1871 a patent was obtained for the use of arsenic against the Cotton-Worm by Mr. Thomas W. Mitchell, of Richmond, Tex., (No. 110774, January 3, 1871; reissue No. 5935, June 30, 1874; 92 grains of opaque arsenic, or 293 grains of transparent arsenic, to one pint of water).

A more complicated compound, "JOHNSON'S DEAD SHOT," has been patented by Judge J. W. Johnson, of Columbus, Tex. (No. 151666 June 2, 1874), consisting of 8 oz. arsenious acid, 1 oz. cyanide of potassium, 8 oz. dextrine, dissolved in 40 gallons of water. One of the claims for this compound was that the vapor of the cyanide of potassium even killed the moths which came in the vicinity of the plants that had been sprinkled with the "Dead Shot". Experience has shown that the claim was unwarranted, and, in fact, in the packages offered to the public, Judge Johnson did not adhere to the specification, being finally afraid to use the cyanide of potassium, and making a mixture composed of 3 lbs. of commercial arsenic, 1 lb. of starch, 1 lb. of salts of tartar, ground up together. This was made up in powder packages to be used at the rate of 5 lbs. to 500 gallons of water and sprayed by means of his patent sprinkler presently to be described. This was found to have the same drawback, common to arsenical mixtures, of injuring the plant, and the later packages, advertised under the name of "Johnson's Improved Dead Shot," put up in 4 lb. tin boxes and to be used at the rate of 4 lbs. to 500 gallons of water, consist (according to the inventor's own statement to me) of 2 lbs. of commercial arsenic with a due proportion of rosin, caustic soda, and sulphate of copper, all boiled together. This is sold at \$1.25 per box. It has, however, proved too often unsatisfactory and inefficient, and Mr. Johnson has been obliged to add or recommend the addition of one pound of Paris green to the mixture.

ARSENIATE OF SODA.—This has the advantage of being perfectly soluble in water, but has the same disadvantages as commercial arsenic. For a number of years an arsenical compound has been advertised under the name of "Potato-pest poison," by the Lodi Chemical Works of Lodi, N. J. It is put up in pound packages, which are sold at \$1 each, with directions to dissolve 4 ounces in 2 quarts of hot water, then pour into

a barrel containing 30 gallons of cold water, and use on the plants in as fine a spray as possible.

A patent (No. 151078, May 19, 1874) was obtained by Messrs. J. D. Braham and A. Robira, of Galveston, Texas, for their "TEXAS COTTON WORM DESTROYER," which is essentially the same as the Lodi preparation, and put up at the New Jersey works for the Galveston firm. Fifty grains of arseniate of soda and 200 grains of dextrine are to be dissolved in one gallon of cold water. The mixture was formerly sold at the exorbitant price of \$1 per lb., and is now offered for 50 cents per lb. It is put up in packages of 60 and 100 lbs., and thus sold at a discount of 10 per cent. It is to be used at the rate of 4 ounces of the mixture to about 40 gallons of water, making the cost of one application per acre about 12½ cents. It has been extensively used.

Another "pest poison," also essentially the same as the Lodi preparation, but faintly colored with rose aniline, is put up by the Kearney Chemical Works of New York, in ½ lb. packages, sold at 50 cents, and to be dissolved in 60 gallons of water.

London Purple.

This powder is obtained in the following manner in the manufacture of aniline dyes. Crude coal-oil is distilled to produce benzole. This is mixed with nitric acid and forms nitro-benzole. Iron filings are then used to produce nascent hydrogen with the excess of nitric acid in the benzole. When distilled, aniline results: to this arsenic acid, to give an atom of oxygen which produces rose aniline, and quicklime are added to absorb the arsenic. The residuum which is obtained by filtration or settling is what has been denominated "London Purple," the sediment being dried, powdered, and finely bolted. The powder is, therefore, composed of lime and arsenious acid, with about 25 per cent. of carbonaceous matter which surrounds every atom. Experiments which I made with it in 1878 impressed me favorably with this powder as an insecticide, and its use on the Colorado potato-beetle by Professors Budd and Bessey, of the Iowa Agricultural College, proved highly satisfactory. I was, therefore, quite anxious to test its effect on the Cotton-Worm in the field on a large scale, and in the winter of 1878-'79 induced the manufacturers to send a large quantity for this purpose to the Department of Agriculture. The analysis made of it by Professor Collier, the chemist of the Department, showed it to contain:

	Per cent.
Rose aniline.....	12.46
Arsenic acid.....	43.65
Lime.....	21.82
Insoluble residue.....	14.57
Iron oxide.....	1.16
Water.....	2.27
Loss.....	4.07

 100.00

Through the liberality of the manufacturers, Messrs. Hemingway & Co., a number of barrels of this powder were placed at my disposal the past season and distributed to various observers and agents in Georgia, Alabama, and Texas. Early in the spring Mr. A. R. Whitley, of Franklin Grove, Illinois, found it to be a perfect antidote to the canker-worms which had not been prevented from ascending his apple-trees, and the experiments of those whom I had intrusted to make them on the Cotton-Worm, as well as those made under my own supervision, all showed that its effects are fully equal to those of Paris green. Like the latter it kills the worms quickly and does not injure the plants if not applied in too great a quantity. Farther, it also colors the ingredients so as to prevent their being mistaken for harmless material. Finally, its cheap price removes the temptation to adulterate the poison, as every adulteration would prove more expensive than the genuine article. It is even superior to Paris green, as, owing to its more finely-powdered condition, it can be more thoroughly mixed with other ingredients and used in smaller proportion. Experiments on a large scale have been made with the dry application at the rate of 2 lbs. to 18 lbs. of diluents, also at the rates of 1, $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$ lb. to 18 of the diluents. The last proved only partially effectual, and in no case were the plants injured or the leaves even burned. In all but the last case the worms were effectually killed, but as the mixture, at the rate of $\frac{1}{4}$ lb. was applied with greater care and regularity than is generally had on a large scale, and also in very dry weather, the proportion of $\frac{1}{2}$ lb. to 18 of the diluents is most to be recommended. All higher proportions are simply waste of the material.

Like Paris green, it is not soluble,* but is much easier kept suspended in water than the former. If applied in this way some care has to be taken in stirring it in the water, as it has a tendency to form lumps, owing to its finely-powdered condition. Experiments on a large scale with this material diluted in water gave the following results: When used in the same proportion as Paris green, namely, 1 lb. of the poison to about 40 gallons of water, one experimenter reports that the leaves were slightly crisped, while four others report a perfect success, and no injury whatever to the plant. Experiments by myself and Mr. Schwarz showed that when applied in the proportion mentioned and thoroughly stirred up in the water the leaves were partly crisped, though by no means so much as by arsenic, even when applied in weaker solution. When used in smaller proportion, or at the rate of $\frac{3}{4}$ or $\frac{1}{2}$ lb. to 40 gallons of water, it did not burn the leaves and still proved effectual in destroying the worms. Repeated experiments on a smaller scale confirmed these results obtained on large fields, and also showed that the proportion may be still farther reduced, and when applied with great care and in very dry weather $\frac{1}{4}$ lb. to 40 gallons will kill. Still farther reduction in the proportion of the powder used gave negative results.

* The manufacturers can render about 13 per cent. of it soluble if desired.

I would, therefore, recommend the use of $\frac{1}{2}$ lb. of this powder to from 50 to 55 gallons of water as the proportion most likely to give general satisfaction by effectually destroying the worms without injuring the plants.

All that has been said under the head of Paris green as to the desirability of adding a small quantity of flour or other substance to give adhesiveness to the liquid will hold equally true of London purple, but the latter has in many respects a great advantage over the former, especially in its greater cheapness, being a mere refuse which, from its poisonous nature, was a drug to the manufacturers and had to be gotten rid of by being dumped long distances out at sea. This substance can be put upon the market at the bare cost of transportation. It can be sold in New York at the low rate of 6 cents per lb., and there is no reason why it should not be obtained at any of the large shipping points in the South at figures ranging between 7 and 10 cents a pound. This means virtually that the cost of destroying the worms by this powder is reduced to such a minimum as to depend mainly on the labor and the other ingredients or dilutents employed; in other words, that, while the planters, as heretofore, were obliged to pay as much as \$1 for the first cost of the active poison needed for one acre, and never less than 15 cents, he may now obtain it for from 3 to 5 cents.

London purple has this farther advantage over other arsenical compounds hitherto employed: Its finely-pulverized condition seems to give it such penetrating power that, when used in liquid, it tints the leaves so that cotton treated with it is readily distinguished at a distance, the general effect being quite marked as compared with any of the other poisons similarly applied. It seems also to be more effectually absorbed into the substance of the leaf, and is therefore more persistent. At the same time experience shows that it does not injure the squares any more than Paris green.

Pyrethrum Powder.

The insecticide and insectifuge qualities of the dried and finely-powdered flower-heads of different species of *Pyrethrum*, and the harmlessness of the powder to man, to other animals, and to plants, have long since been known. Used against various household pests under the names "Persian Insect Powder" or "Dalmatian Insect Powder," it has hitherto been put up in small bottles or packages and sold at such high prices as to preclude the idea of using it on a large scale in the field. The so-called Persian Powder is made from the flowers of *Pyrethrum carneum* and *P. roseum*, while that from *P. cinerariæfolium*, a native of Dalmatia, Herzegovina, and Montenegro, is more generally known as Dalmatian Powder. Some interesting experiments made during the year on different insects by Mr. William Saunders, of London, Ontario, show that the use of this powder may be satisfactorily extended beyond the household, while a series which I made in the summer of 1878 with the same powder on the Cotton-Worm showed it

to have striking destructive powers, the slightest puff of the powder causing certain death and the almost instant dropping of the worm from the plant. Repeated on a still more extensive scale the present year at Columbus, Tex., the powder proved equally satisfactory in the field.

Here, then, we have a remedy far exceeding any other so far known in efficacy and harmlessness to man and plant, and the only question in my mind has been to reduce its cost. There was some hope of doing this by ascertaining the destructive principle, and it is to Prof. E. W. Hilgard, of the University of California, that we owe the first accurate determination of the same. The following extract from a letter received from Professor Hilgard last September indicates the results of some of his experiments :

DEAR SIR: Yours of 22d is to hand. I have had Milco's product in hand for some time, and have tried it on various bugs both in powder and infusion. To understand the best manner of using it in each case, it must be kept in mind:

1. That the active substance is a volatile oil.
2. That said oil, under the influence of air, not only volatilizes, but is also oxidized, and thereby converted into an inert resin.

It follows from 1, that the pyrethrum is at a disadvantage when used in the shape of powder in the open air, especially when the wind blows; from 2, that it is of the greatest importance that the substance should be fresh, or should have been kept tightly packed, for the same reason that hops must be similarly treated.

Hence I find that Milco's fresh powder is of greater efficacy than the best imported, although some of the latter contains twice as much matter soluble in ether; but the extract from the "buhach" is a clear greenish oil, while that from imported powder, and especially that from "Lyon's magnetic"—ground-up refuse, stems, &c., as I take it—is dark and thickish, or almost dry and crumbly.

Like all volatile oils, the essence of pyrethrum is soluble in water to some extent, and the tea from the flowers, and to a less extent, that from the flower-stems and leaves, is a valuable and convenient insecticide for use in the open air, provided that it is used at times when it will not evaporate too rapidly, and that it is applied in the shape of spray, whose globules will reach the insect despite of its water-shedding surfaces, hairs, &c. Thus applied, I find that it will even penetrate the armor of the red scale bug—or rather, perhaps, get under it—so that the bug falls off dead, in a day or two. The hairy aphides are the most troublesome, and require a strong tea of the flowers, atomized. The diluted alcoholic solution can, of course, be made as strong as you please, and will kill anything entomological.

Some persons have tried the decoction, and have of course failed, as the oil is dissipated by boiling.

My own experiments and those of Professor Hilgard were made with the powder from plants grown in California by Mr. G. N. Milco, of Stockton, and this powder, when used fresh, I have found to be more powerful than the imported kinds. Mr. Milco, a native of Dalmatia, has been cultivating the *P. cinerariæfolium* in California in constantly increasing area for the past three years, and deserves great credit for his efforts in introducing it. The Californian product is put upon the market in neat bottles and packages under the name of "Buhach," and I am under obligations to Mr. Milco for the liberal supply which he has placed at my disposal free of cost, wherewith to carry on my experiments. Before considering the cost of using this insecticide in the cotton-field it will be well to summarize the results of these experiments.

Pure Pyrethrum powder, mixed with a small quantity of finely-powdered rosin, was applied to the under-side of the leaves by means of a small pair of bellows. Taking advantage of the direction of the wind, and using the bellows freely, all the upper leaves of the plants were found to be well powdered, and consequently almost all the worms upon these leaves received at least some particles. The smaller worms died in convulsions in from 10 to 20 minutes, according to their size, and to the quantity of powder they have received. Larger worms soon became uneasy, and finally fell to the ground, where they invariably died in from 5 to 24 hours.

Every attempt to restock with worms a freshly-powdered plant failed. They evidently do not like the smell of the powder, and throw themselves from the leaves until they either fall to the ground or reach a leaf which has not been powdered.

Diluted with flour in varying proportions from one part of each up to one part of Pyrethrum and ten of flour, it produced equally good results as when pure. Mixed with 16 parts of flour, it proved at first insufficient, but upon being kept in a tight glass jar for two weeks, it evidently gained in power, for it then proved almost as effectual as the stronger mixtures. The powder can be successfully sifted on the plants during cloudy days or during the evening when the worms are on the upper side of the leaves. On sunny days, or when the worms are just hatched, it is more necessary to apply it to the under side of the leaves, as it acts only when coming in actual contact with the worms.

A strong decoction of the powder applied to the leaves produced no effect; nor did the worms appear to suffer from eating leaves thoroughly soaked with this decoction.

An alcoholic extract of the powder, diluted with water at the rate of one part of the extract to 15 of water, and sprayed on the leaves, kills the worms that have come in contact with the solution in a few minutes. The mixture in the proportion of one part of the extract to 20 parts of water was equally efficacious, and even at the rate of 1 to 40 it killed two-thirds of the worms upon which it was sprayed in 15 or 20 minutes, and the remainder were subsequently disabled. In still weaker solution or at the rate of 1 to 50 it loses in efficacy, but still kills some of the worms and disables others. I confidently recommend, therefore, the alcoholic extract of Pyrethrum, diluted at the rate of 1 part of the extract to 40 parts of water, and sprayed upon the plants as an effectual remedy against the worm.

The extract is easily obtained by taking a flask fitted with a cork and a long and vertical glass tube. Into this flask the alcohol and Pyrethrum is introduced and heated over a steam tank or other moderate heat. The distillate, condensing in the vertical tube, runs back, and, at the end of an hour or two the alcohol may be drained off and the extract is ready for use.

Let us now briefly consider the approximate cost of using this mate-

rial at present figures. The powder is now selling in California at wholesale, in 8-lb. packages, at \$1.25 per lb.; but from facts kindly communicated by Mr. Milco, it appears that he has raised as much as 647 lbs. to the acre, and that the cost of production, milling, &c., on a large scale, need not exceed 6 to 7 cents per lb., because in the experiments attending the introduction of the plant many obstacles and expenses incident to new enterprises have had to be met. The plant is wonderfully free from insect enemies and blooms all through the summer, and there seems no good reason why it should not grow in most of the Southern States.

Carefully estimating from the results of experiments made, it will require about one and three-quarter pounds of the Pyrethrum powder to go over an acre of cotton at medium height; in other words, that quantity of Pyrethrum to 20 lb. of flour or other diluents will answer the purpose. Such being the case, the question as to whether the Pyrethrum can be used as a substitute for Paris Green, London Purple, and other arsenical powders resolves itself in one of relative market price, and if Mr. Milco's estimates are warranted—and no one in the country is better able to state the facts or give the figures on the subject—the Pyrethrum may be produced as cheaply as even London Purple. It is a question which future experience alone can determine, but that the prospects are encouraging there can be no question, and it is highly probable that the planter in the future will make it a rule to grow a patch or a few rows of this most useful plant as a ready means wherewith to protect his crop from the worm whenever the occasion for so doing presents itself.

So far as experiments have been made there would seem to be a decided advantage in point of economy in the use of the crude powder, since, in the ordinary methods of spraying, 40 gallons of liquid are required for an acre, and to produce this amount of diluted extract of Pyrethrum at the above figures would require about 6 lbs. of powder. This diluted extract has the advantage, however, over every other liquid so far used that it contains no solid and obstructing particles. It may, therefore, doubtless be used in a much finer spray than any of the other poisons.

Kerosene Oil.

It is a well-known fact that this is a most powerful insecticide, and experiment has shown that a fine spray of kerosene applied to the leaves will kill all worms thereon in a remarkably short time. This deadly effect is produced by the contact, the smallest quantity of the oil applied to any part of the worm causing instant death. Unfortunately, however, the oil has the same pernicious effect on the leaves, and the difficulty of applying it in such fine spray as not to injure the plants, and at the same time touch every worm, has not yet been overcome. The same objection applies to the use of the oil mixed with water. An

attempt has been made to apply the oil in form of vapor by means of steam. There is no question but that the worms are effectually killed by this application, and, perhaps, without injury to the plant, but the machine necessary for the production of the vapor, which will be described below, is so ponderous and awkward as to be of no practical value.

When mixed with a sufficiently large quantity of wood ashes, kerosene can be applied to the leaves without damaging them, but the mixture cannot be sprinkled in particles small enough to have much effect on the worms. A patent was obtained by Mr. George W. Powell, of Halifax County, Virginia, in April, 1876, for the simple mixture of one-half pint of kerosene to one quart of fine, dry, well-sifted wood ashes. The patentee claims that by sprinkling or scattering this preparation lightly over the plants it will drive off or destroy insects of every kind without injury to the leaves.

When converted into soap by means of lye and boiling, kerosene, like any other oil, loses much of its deadly quality; hence its application in soap form has but little effect.

While kerosene is thus of little value for direct use on the plants, it is most valuable for destroying the worms that are in one way or another brushed off the plants, as already described (p. 54). It may be successfully used also in pans around lamps as a means of insuring the destruction of the moths attracted thereto.

Cotton-seed Oil.

This cheap product has almost the same deadly effect on the worms as the more volatile kerosene oil, but it also kills the leaves of the plant even when applied to them in the form of a fine spray. The same obstacles as those mentioned in connection with kerosene oil also render a successful application of this and other cheap oils impracticable. It occurred to me that by making a soap by using this oil and the ashes from cotton-seed hulls, which are so generally used for fuel in the manufacture of cotton-seed oil, we might obtain a liquid that could be sprayed upon the plant with good effect, thus, on the principle *similia similibus curantur*, employing the products of the plant itself as an antidote to its worst enemy, these products being easily obtainable at nominal cost at all points where cotton-seed oil and cake are being manufactured. The experiments made by Mr. Schwarz certainly show that there is a possibility of successfully utilizing these materials where they can be abundantly and cheaply obtained. A strong suds from this soap was found to destroy the young worms, but seems to have little effect on the larger or full-grown ones. In this respect it acted very much as any other strong soap suds would, and it cannot be said to have any advantage over other saponaceous compounds except in the cheapness and abundance of materials at command by planters in the vicinity of cotton-seed oil factories. Its efficacy is greatly increased by the addition

of a small proportion of London Purple or Paris Green, but it is more than probable that under ordinary circumstances this saponaceous mixture would prove more expensive and troublesome than the other mixtures already recommended.

Carbolic Acid.

The late Thomas Affleck was a firm believer in the efficacy of this substance in preventing the moth from depositing her eggs upon the plant, and strongly urged its use in his correspondence with me. The saponaceous compound has been more or less successfully used against many other insects, and, so long as the smell of the acid remained upon the leaves, the moth would doubtless avoid such leaves for others that had not been treated. Dr. Phares pretty thoroughly tried it, however, some ten years ago, without satisfactory results, and the fact that it is so commonly used in the South for the "Screw Worm" and as a general disinfectant, and is yet not employed against *Aletia*, is fair evidence that it has little value in this connection. My own experience in trying it for other worms is that it has little effect on the worm when made weak enough to be harmless to the plant.

Sulphur.

A machine for the application of the vapor of this mineral is described farther on; but, so far as I can see, the machine has not been used to any extent. Nor is it probable that sulphur vapor will destroy the worms when applied in the open air.

Extracts or Decoctions from various Plants.

There is a wide field for experiment in this direction, though those which have so far been carried on under my direction or independently by others, have so far given very unsatisfactory results. Mr. Schwarz carried on a series of tests with some of the more common and promising plants that grow in South Texas. Strong extracts of Poplar and Hickory leaves; of the leaves and berries of the Poke Weed (*Phytolacca decandra*); of Cocklebur (*Xanthium strumarium*); of Wild Hemp (*Ambrosia trifida*); of *Heliophytum indicum*, *Euphorbia marginata*, and *Sesbania vesicaria*, produced no effect whatever. Others that have a strong smell, like the different species of Goat Weed (*Oroton texanum*, *O. glandulosum*, *O. lindheimeri*, *O. capitatum*, and *O. monanthoginum*), or poisonous properties like the different species of *Solanum* (*S. cornutum*, *S. elegnifolium*, and *S. carolinense*), gave equally unsatisfactory results.

Strong decoctions of the leaves and green berries of the China tree (*Melia azedarach*) killed a portion of the young worms when copiously used in spray, but had no appreciable effect on the larger worms. The "Coffee Weed" (*Cassia occidentalis*), used in the same way, was less injurious, though evidently distasteful to the worms, and the same proved true of Jamestown Weed (*Datura stramonium*) and tobacco.

Yeast Ferment: Fungus Infection.

The fact that insects, like other animals, are subject to diseases of an epidemic nature and of a fungus origin has led some persons to hope and believe that the germs of destruction could be, so to speak, artificially sown among those which it was desired to destroy. Dr. J. L. LeConte, of Philadelphia, was the first in this country, so far as I am aware, to suggest the introduction and communication of such diseases at pleasure for the destruction of insect pests, in a paper read at the Portland (1874) meeting of the Association for the Advancement of Science. Dr. H. A. Hagen, of Cambridge, Mass., has recently elaborated the idea, and strongly recommended as a general insecticide the use of beer-mash, or diluted yeast, applied with a syringe or a sprinkler. I quote the following somewhat sanguine words from an article which he published in the June number of the *Canadian Entomologist*:

"Dr. Bail asserts that he has proved by many skillful experiments that four species of microscopical fungi are merely different developments of the same species. One of them, the fungus of the common house-fly, is the vexation of every housekeeper. The dead flies stick in the fall firmly to the windows, or anywhere else, and are covered by a white mold not easy to be removed. The second is the common mold, known to everybody, and easily to be produced on vegetable matter in a damp place. The third is the yeast fungus, a microscopical species, and the basis of the work done by yeast of fermentation. The fourth is a small water-plant, known only to professional botanists. Dr. Bail contends that the spores of the fungus of the house-fly develop in water in this last species, out of water in mold, and that the seeds of mold are transformed in the mash-tub into yeast fungus.

"The experiments made by Dr. Bail cover a period of more than a dozen years, since the numerous objections which were made against his results induced him to repeat again and again his experiments in different ways. I am obliged to state that even now prominent botanists do not accept Dr. Bail's views, which he maintains to be true and to be corroborated by new and sure experiments. This question, important as it may be for botanists, is without any influence regarding my proposition, as Dr. Bail has proved that mold sowed on mash produces fermentation and the formation of a yeast-fungus, which kills insects as well as the fungus of the house-fly. I was present at the lectures of Dr. Bail before the association of naturalists, in 1861, which were illustrated by the exhibition of mold grown on mash on which the fungus of the house-fly had been sown, and by a keg of beer brewed from such mash, and by a cake baked with this yeast.

"Dr. Bail has proved by numerous experiments that healthy insects brought in contact with mash and fed with it are directly infested by the spores of the fungus with fatal consequence. These facts, not belonging strictly to the main part of his experiments, were observed first by chance and later on purpose. The most different insects, flies, mosquitoes, caterpillars, showed all the same results. The experiments were made in such a delicate manner that a small drop of blood taken with an oculist's needle from the abdomen of a house-fly left the animal so far intact that the same operation could be repeated in two days again. Both drops examined with the microscope proved to be filled with spores of fungus.

"Considering those facts, which are doubtless true, and considering the easy way in which the poisonous fungus can always and everywhere be procured and adhibited,

I believe that I should be justified in proposing to make a trial of it against insect calamities. Nature uses always to attain its purposes the most simple and the most effectual ways; therefore it is always the safest way to follow nature.

"Beer mash or diluted yeast should be applied either with a syringe or with a sprinkler; and the fact that infested insects poison others with which they come in contact will be a great help. Of course it will be impossible to destroy all insects, but a certain limit to calamities could be attained, and I think that is all that could reasonably be expected. In greenhouses the result would probably justify very well a trial, and on currant worms and potato bugs the experiment would not be a difficult one, as the larvæ of both insects live upon the leaves, which can easily be sprinkled. But it seems to me more important to make the trial with the Colorado grasshopper. I should recommend to infest the newly-hatched brood, which live always together in great numbers, and I should recommend also to bring the poison, if possible, in contact with the eggs in the egg-holes, to arrive at the same results, which were so fatal to Mr. Trouvelot's silk-raising. After all, the remedy proposed is very cheap, is everywhere to be had or easily to be prepared, has the great advantage of not being obnoxious to man or domestic animals, and if successful would be really a benefit to mankind. Nevertheless, I should not be astonished at all if the first trial with this remedy would not be very successful, even a failure. The quantity to be applied and the manner of the application can only be known by experiment, but I am sure that it will not be difficult to find out the right method. I myself have more confidence in the proposed remedy, since it is neither an hypothesis nor a guess-work, but simply the application of true and well-observed facts. I hear the question—When all this has been known for so long a time, why was it not used long ago? But is that not true for many, not to say for all, discoveries? Most of them are like the famous Columbus egg."

It will be seen that Dr. Hagen attaches little importance to the present opinion and judgment of mycologists as to the non-identity of the several fungi alluded to. I have corresponded with some of the leading cryptogamists of this country on this subject, and they are quite unanimous in the opinion that there is no one "of the least reputation," to use Professor Farlow's words, who admits that there is any connection between the fly fungus, known as *Empusa muscæ* but belonging to the genus *Saprolegnia*, and the yeast fungus, *Saccharomyces cerevisiæ*. It is to be regretted, also, that more precision has not been used by Dr. Hagen in referring to these fungi, for the "common mold known to everybody" is most vague, since many different species of mold are recognized by specialists, while "a small water-plant, known only to professional botanists" is such an indefinite expression as to inspire little confidence in the thoroughness of Dr. Bail's experiments. Leaving to the specialist, however, the question as to the kind of relation existing between the lower forms of fungi intended to be referred to by Dr. Hagen, I felt that the suggestion coming from so eminent an entomologist was well worthy of practical trial. I took occasion, therefore, to experiment with beer mash by spraying and sprinkling it upon various plants that were to be fed in my vivaria to Lepidopterous larvæ. The principal larvæ thus experimented with were of *Papilio asterias*, *Danais archippus*, and *Pieris rapæ*. The results gave no encouragement to the hope that anything practical would result from the proposed remedy. The larvæ fed with equal avidity and went through their transformations as well as the

same species had done on repeated occasions without being treated to beer mash. An incident connected with these experiments which I made is, however, well worthy of being mentioned; because it shows how very easily single experiments may lead to false hopes and conclusions. A certain proportion of the last-named larvæ—the proportion differing in the different lots treated—perished before or while transforming to the chrysalis state. They became flaccid and discolored, and after death were little more than a bag of black putrescent liquid. I should have at once concluded that the yeast remedy was a success had I not experienced the very same kind of mortality in previous rearing of this larva, and had I not, upon returning to the field from which the larvæ in question were obtained, found a large proportion similarly dying there.

Though from this experience I had little faith in the value of the proposed remedy as against the Cotton Worm, I nevertheless took pains to have it tested both by Professor Smith in Alabama and Professor Willet in Georgia, sending a copy of Dr. Hagen's article to each, with the request that they make the experiments thorough and, so far as possible, in the open air. The experiments were made in each instance during the latter part of the season when the vitality of the worms was already considerably lowered, a condition which, in my experience with fungus diseases in insects, was eminently favorable for satisfactory trial. Professor Smith, who used the yeast ferment, had a similar experience with my own, the result being that the worms were not affected one way or another. Professor Willet's experiments, on the contrary, seem to indicate that a larger proportion of the worms treated with the ferment perished, as compared with those that were not so treated. I therefore quote his report in full, the experiments having covered a period from September 20 to November 6:

"On going to Montezuma, Macon County, Georgia, September 20, where the cotton caterpillars were said to be in abundance, it was found that they were for the most part "webbed up." Moreover, a Northeaster with rain set in which prevented operations in the field for several days. It was, therefore, determined to conduct the experiments within doors.

After the sun came out on the 24th, however, two attempts were made to operate in the field, with very interesting but unexpected results. The caterpillars being much scattered in the cotton-field it was thought best to collect them together. Accordingly, September 24, at 11 a. m., 330 were gathered and colonized on two rows of cotton, in the garden of Rev. A. J. Cheves, at whose house the experiments were made. They were placed, 165 on each row, 5 caterpillars to each stalk. Beer and diluted yeast were sprinkled, each over half of one of the rows. The other row was left undisturbed. The next day at 1 p. m. the caterpillars were examined and counted. No dead ones were found. Of the caterpillars, 80, sprinkled with beer, only 10 larvæ and pupæ were found; and of the 85 sprinkled with yeast only 13 larvæ and pupæ were found; only 23 out of 165 being accounted for. This deficit of 142 was very remarkable. It could not be explained by the rapid poisonous effects of the beer and yeast, for no dead were to be seen. And though many wasps and bees were attracted by the beer, only one larva was seen to have been attacked by them; a feeble one had been seized by a yellow-jacket (*Vespa germania*). The row, which had received no beer nor yeast

was then examined, and 53 larvæ counted, leaving 112 unaccounted for. It was suspected, then, that the caterpillars had deserted the cotton and crawled away in the night in search of better pastures. Accordingly, September 26, 53 caterpillars were placed on 12 stalks of cotton and sprinkled with beer, and 15 others on a row alongside, but not sprinkled. They were watched during the day; three or four fell to the ground, but did not crawl away; the others seemed not disposed to eat. A swarm of flies, bees, wasps, &c., came to suck at the beer, but did not disturb them, with one exception, as before. The next day 6 of the 53 sprinkled with beer were found; and 2 of the 15 not sprinkled. The remainder had without doubt decamped during the night. This hint should be remembered hereafter in future experiments in the field. Only the dead and wounded should be numbered as the victims of poison. The missing may be vagabond deserters.

The experiments, the results of which are given below, were necessarily conducted within doors. The materials employed to produce the yeast fungus were "yeast cake," brown sugar, and water. One pound of brown sugar to one gallon of water, with half of a "yeast cake," fermented readily, and was applied when in active fermentation. This is called hereafter beer-mash or beer. A portion of yeast cake mixed with flour and water also fermented quickly, and was applied diluted with an equal quantity of water. This is called yeast. Molasses or sirup can be substituted for the sugar.

On September 21, 28 caterpillars about half grown were placed in each of 3 paper boxes with tops. The 28 caterpillars in box No. 1 were supplied, as they needed, with fresh cotton leaves wet on one side with beer-mash. The 28 in box No. 2 were supplied, likewise, with cotton leaves wet on one side with yeast. The 28 in box No. 3 were supplied with cotton leaves wet with water to serve as a basis of comparison, these being in the natural state, except as to confinement, want of sun, and excess of moisture. September 23, 20 caterpillars were placed in each of three other paper boxes, larger and better arranged. The 20 caterpillars in box No. 4 were supplied with leaves wet with beer-mash; those in box No. 5 with leaves wet with yeast; and those in box No. 6 with leaves wet with water. The two series were duplicates, except that the last had better quarters.

They were cared for thus till September 27, when they were removed to Macon, Ga., where the experiments were concluded. All the larvæ except one webbed up by September 30; the first moth appeared in box No. 2, October 3, and the last one, in box No. 6, October 13. The influence of the cool weather is seen in the slowness of the transformation.

Only a few died in the larva state; and it was only when most of the moths had come out that a difference in the results of the boxes was observed. It was then seen that a considerable number failed to pass through the pupa state, and that the largest number so failing were of those that had been fed on beer-mash and yeast.

As this seemed to lend countenance to Dr. Hagen's theory, an effort was made to repeat the experiment with a new lot of caterpillars. A small number were procured from a field near Macon, October 14, and placed in two paper boxes. The 12 in box No. 7 were fed on cotton leaves wet with beer-mash, and the 12 in box No. 8 were supplied with cotton leaves. October 18 all in box No. 7 had webbed up, some having eaten little or no leaves, and none of them having consumed the leaves and beer-mash to any great extent. All were nearly full-fed when caught, and were very sluggish from the coldness of the weather. The first moth came out October 31, and the last November 5.

The results in full are shown in the following tabular form:

Experiments with beer-yeast on three series of cotton caterpillars.

Living larva.	Dead larva.	Became pupa.	Became moth.	Total larvae (dead) and pupae.	Total loss of larvae and pupae.	Loss as larvae.	Loss as pupae.
FIRST SERIES.							
<i>September 21.</i>							
With beer.....	<i>Sept. 27.</i> 2	<i>Sept. 23 to 30.</i> 17	<i>Oct. 3 to 13.</i> 5	19	$\frac{1}{2}$ = 73 per cent.....	$\frac{1}{2}$ = 10 per cent.....	$\frac{1}{2}$ = 63 per cent.
With yeast.....	5	16	6	21	$\frac{1}{2}$ = 71 per cent.....	$\frac{1}{2}$ = 23 per cent.....	$\frac{1}{2}$ = 48 per cent.
With water.....	3	23	11	25	$\frac{1}{2}$ = 56 per cent.....	$\frac{1}{2}$ = 8 per cent.....	$\frac{1}{2}$ = 48 per cent.
SECOND SERIES.							
<i>September 23.</i>							
With beer.....	<i>Sept. 30.</i> 1	<i>Sept. 23 to 30.</i> 17	<i>Oct. 3 to 13.</i> 7	18	$\frac{1}{2}$ = 61 per cent.....	$\frac{1}{2}$ = 5 per cent.....	$\frac{1}{2}$ = 56 per cent.
With yeast.....	0	19	9	19	$\frac{1}{2}$ = 52 per cent.....	0 = 0 per cent.....	$\frac{1}{2}$ = 52 per cent.
With water.....	0	23	17	23	$\frac{1}{2}$ = 15 per cent.....	0 = 0 per cent.....	$\frac{1}{2}$ = 15 per cent.
THIRD SERIES.							
<i>October 14.</i>							
With beer.....	<i>Oct. 20.</i> 0	<i>Oct. 20.</i> 13	<i>Nov. 6.</i> 11	13	$\frac{1}{2}$ = 84 per cent.....	0 = 0 per cent.....	$\frac{1}{2}$ = 84 per cent.
With water.....	0	13	11	12	$\frac{1}{2}$ = 84 per cent.....	0 = 0 per cent.....	$\frac{1}{2}$ = 84 per cent.

It will be observed that the mortality, as shown in the 7th column, was considerable in all of the first three boxes, being 73, 71, and 56 per cent. for the beer, yeast, and water, respectively, and only somewhat less for the second series, being 61, 52, and 15 per cent. But the ratios of the deaths in boxes 1, 2, 4, and 5, where the leaves were wet with beer and yeast, to those in boxes 3 and 6, where water alone was used, is noticeably great in both series. The same may be seen in column 5, showing the moths that came out. In the first series, the moths that issued were 5, 6, and 11 for the beer, yeast, and water, respectively, and 7, 9, and 20 for the similar boxes of the second series, being only one-third to one-half as many for the beer and yeast as for the water. In the third series the mortality is small, and is the same for both beer and water. The larvæ, when introduced into these two boxes, were nearly full-fed, and sluggish from cold, and ate but little.

The caterpillars that died were all young. It is possible that their deaths may have been caused by their bodies being clogged by the viscidness of the beer and yeast. Unless the effects of the yeast fungus upon them in their natural conditions in the field are more decided, little good will be done in cutting short their ravages as caterpillars, for most of them will survive till the chrysalis stage at least.

The mortality occurred mainly in the pupa state, the vitality being sufficient to carry the larvæ through the first stage of life, but not through the second.

If the fungus produced any effect in these experiments, it did not appear to extend to the moth state, for the moths, on coming out, appeared as perfect and lively as the moths in a state of nature. Could they, however, have been watched through their natural lives, and the number and soundness of their eggs, and the resulting brood of caterpillars observed, the effects of the fungus might have been found to extend beyond the chrysalis, and might tend to the enfeeblement of the race, as in the Silk Worm in Europe.

Such are the facts. On the whole, the experiments cannot be regarded as yielding any determinate conclusion. The confinement of the larvæ in small boxes, without air and sun, and with an excess of moisture, was unlike the conditions of nature, and not conducive to health. The number of larvæ also was too small as a safe basis of induction. Had the colony in each box been increased from a quarter of a hundred to a full hundred, the percentages might have been much changed.

But the results are suggestive. The greater mortality of the larvæ fed on beer and yeast, and in two independent series, may be mere coincidences. But such coincidences challenge attention, and encourage a repetition of the experiments under more favorable circumstances, and on a larger scale.

Unfortunately the value of these experiments by Professor Willet is impaired by failing to take account of so large a number of the larvæ in each set of the first two series. A careful analysis of the table and of Professor Willet's own conclusions will show that the results are vitiated and that the inferences drawn are not warranted, since we do not get the percentage of loss of the whole number commenced with, but of only a portion.*

The great difficulty in the way of propagating such epidemic diseases at pleasure among plant-feeding insects is that, as past experience shows, there must be certain conditions of the insects favorable to the growth

* Noticing some of the discrepancies when preparing the MS. for the printer, we pointed them out to Professor Willet, from whom we received, after the above was in type, explanations which still further mar the results. The three pupæ in the second series that are additional to the number of larvæ commenced with, and treated with water only, were intruding larvæ, and not improbably the three lost sight of in the other two boxes; while at one time the minute red ants, so troublesome in the South, got into the boxes, and as they would naturally be most attracted to the larvæ sprinkled with beer or yeast, it is fair to presume that such larvæ suffered most from their attacks.

of the fungus, and the comparative rarity of these fungus epidemics indicates how seldom all these necessary conditions are presented. While, therefore, I am by no means as sanguine as Dr. Hagen of practical results flowing from his suggestions, they are nevertheless worthy of more extensive and careful trial than I have been able to give this year.

Machines and Contrivances for powdering.

Before applying any poison in powder form it must be mixed with some of the diluents already mentioned. This mixing, generally done by farmers in a most primitive way by simply stirring the poison into a kettle or wooden box full of flour or other diluent, is a matter of no small importance, as the success or failure of the application largely depends on the way in which the mixing has been done.

Mr. George Little, of Columbus, Tex., has constructed a very simple and useful contrivance for mixing the ingredients. It consists of a barrel which has a longitudinal wooden axle projecting somewhat at each end. Five or six staves run through the barrel longitudinally, but do not project at either end, and on one side is an aperture large enough to admit the ingredients. When they are in, the aperture is closed and the barrel is placed over a large open box, or fixed in any way so that it can be revolved by means of a handle attached to the projecting axle. By this simple and cheap contrivance much labor is saved and a thorough mixing assured, while all possible danger which might be incurred by hand-mixing is avoided.

In the matter of applying the powder, many planters prefer simply to scatter it by hand, after the manner of seed-sowing, as being more economical and rapid than any other method in use. It has, moreover, the advantage that, if the plants are high enough, the poison can be applied to the under side of the leaves. Planters who use this method assert, upon inquiry, that no evil consequences have ever followed their handling of the mixture in this way, but it strikes me as being altogether too unsafe to be recommended.

The usual way of applying dry poison is to sift it over the leaves by means of an ordinary bread-sieve firmly attached to a handle three or four feet long. One or two layers of muslin should be placed in the bottom of the sieve to prevent a too rapid escape of the powder. With some practice in handling these sieves, the foliage of the plants can be pretty evenly dusted, but in general there is considerable waste of the poison by this method. One man can go over one acre per day, but if the plants are high enough, and the soil not too much softened by rains, the poison can be sifted by men on horseback. This secures a more even movement, and consequently less waste of material. Some have tried, with advantage, to dust two adjacent rows at once by means of a stick of suitable length with a sieve fastened to each end, the operator riding between the rows and tapping the stick gently, either with his hand or another stick.

An old sack, such as those used for table-salt, will do good service attached to the end of a stick, but the safest thing for use on a small scale is a perforated tin box (Fig. 37) with a double lid (for security when not in use), and having a handle three or four feet long. By taking the handle of the dust-box in the left hand and tapping the box with a stick held in the right, the poison may be rapidly and evenly distributed, not only on the upper surface of the leaves, but on the under sides as well, if the box is held within and among the plants.

A number of patents have been taken out for machines for dusting the plants with poison, but for some reason or other none have become popular, and I have not been able to learn that any of them are in use at the present time. The object of these machines is to distribute the poison more economically and rapidly than it is done by the simple sifting methods here mentioned. The reason of their not becoming popular is, perhaps, that they do not accomplish their object. The gain in the more economic use of the powder is not large enough to induce the planters to invest in them, especially where labor is cheap, as the employment of an additional hand is more satisfactory.



FIG. 37.—DUST-BOX FOR PARIS GREEN: upside down.

THE WILLIE DUSTER.—Mr. William T. Willie, of Brenham, Texas, has obtained a patent (No. 160986, March 16, 1875) for a contrivance which is but a modification of the method mentioned above of the application of the poison by a man on horseback by means of two sieves fastened to each end of a stick and carried across the saddle. The invention consists of two boxes suspended on a transverse bar, and made adjustable vertically and laterally according to the height of the plants and the width of the rows. The poison is dusted on two rows of plants by means of a system of vibrating sieves at the bottom of the boxes. The apparatus is intended to be secured to a riding-saddle in front of the rider.

In the annexed drawings, Fig. 38 represents a front view, Fig. 39 a sectional view, of the machine, the central figure showing a detailed section of one of the sifting-boxes.

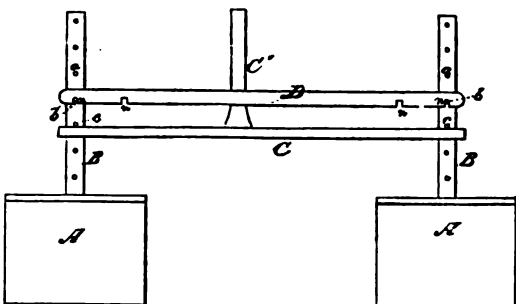


FIG. 38.—THE WILLIE DUSTER: front view.

The letters A A designate two boxes of any suitable capacity, which are constructed with two fixed sieves, *pp*, and movable sieves *p'*, arranged between the fixed sieves and supported upon rods, so as to slide freely when the boxes are vibrated and aid in pulverizing the material, and at the same time scattering it uniformly. The upper sieves *p* will support the bulk of the material free from the scattering sieves *p'*. Each box has secured to it a suspension-standard, B, having a num-

ber of holes, *a*, through it, arranged one above another, and adapted to receive suspension-pins *b c*, and allow the boxes to be adjusted vertically for high or low plants. *C* designates a bar, from which rises a guide-rod, *C'*. This bar *C* is intended to be secured by the middle of its length to the saddle, and through its ends holes are made through which the standards *B B* are passed and sustained by means of the pins *c c*. Supplemental holes are made through the bar *C* to allow the boxes *A* to be adjusted for rows of plants varying in width. *D* designates a bar, the ends of which are slotted longitudinally to receive the standards *B B*, and at or near the middle of the length of this bar *D* a hole is made to receive freely through it the rod *C'*. The ends of bar *D* are notched at *n*, and are attached to the standards *B B* by fitting these notches over the pins *b b*, as shown in the figures.

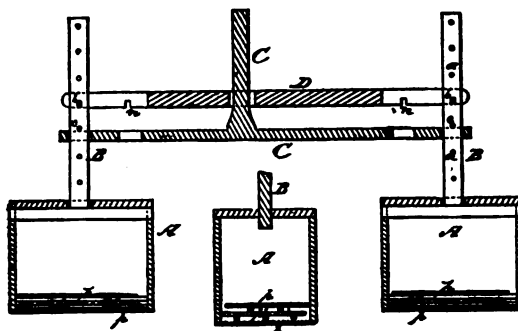


FIG. 39.—THE WILLIE DUSTER: sectional view.

THE HURD BLOWER.—A much more complicated apparatus is that invented by Mr. Charles T. Hurd, of Victoria, Tex. (Patent No. 145949, December 30, 1873). It is intended to be attached to a cultivator or similar machine, and is drawn over one row of plants at a time. It consists of a fan or blower, inclosed in a cylindrical casing, and conjoined with a box containing the poison. The powder is scattered over the plants by means of a vibrating wire screen or cloth at the bottom of the box, and at the same time converted into a cloud of dust by a current of air created by the fan already mentioned, and which is operated by a pulley or band running from the axle of the blower to a wheel on the supporting axle of the cultivator.

In the annexed drawings Fig. 40 represents a sectional elevation of the apparatus

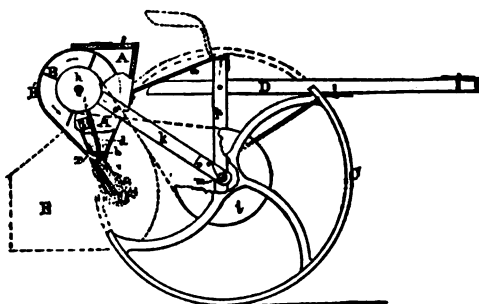


FIG. 40.—THE HURD BLOWER: sectional elevation.

as attached to a cultivator, showing one end of the box *A* partly broken away; Fig. 41, a plan view, with a part of the blower-box removed; Fig. 42, a rear view of the blower-box and powder-box as attached to the cultivator axles.

A represents an oblong box, tapering to the bottom, which contains the powdered poison, having a flap or door, *f*, on its top, and opening at said bottom onto a wire screen or cloth, *b*, running from end to end of the box, which screen is oscillated

lengthwise and across the row of plants by a lever, *d*, pivoted on one side of the box *A*, and engaged at the other end against a rotating cam, *e*, upon the axle of the blower *B*. A spring, *l*, keeps the lever engaged with face of the cam. The blower *B* is confined alongside of the box *A* in a cylindrical casing, *B'*, of a common form, and is mounted on a horizontal axle, *g*, which ends in a pulley, *h*, opposite to another pulley, *i*, upon the supporting-axle *m* of the cultivator.

The box A and the blower-box form one whole box, and is supported at either end by arms *k k*, which are centered upon the said supporting axes *m m* for the purpose of allowing the box A to be raised or lowered in the application of the powder. A ratchet or brace, *n*, for this purpose extends from the box A to a convenient part of the cultivator. The orifice *r* of the blower-box opens parallel with or close alongside of the oscillating screen *b*, so that the air current catches and directs the powder against the plants as it is shaken through the screen from the powder-box.

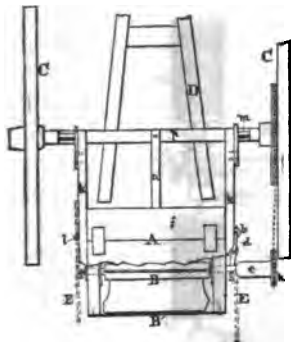


FIG. 41.—THE HURD BLOWER:
plan view.

To confine the powder to the plants and vicinity, side-guards or hoods *EE*, of sheet metal or light wood, as shown by the dotted lines, may be advantageously employed, and be attached to the supports *k k* or other convenient part or place.

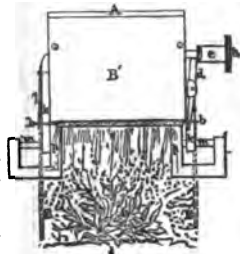


FIG. 42.—HURD BLOWER:
rear view.

A seat may also be attached to the arch *p* or beams *DD* of the cultivator for the use of the driver.

It is evident that this apparatus neither saves material to any great extent nor time in the application of the poison, since only one row of plants is dusted at a time. The only possible advantage it can have is in so distributing the poison in a fine dust that it attaches to the under side as well as to the upper side of the leaves. Some suggestions made by the inventor as to the use of his machine for applying vapor and fine spray of liquid poison will be found mentioned further on.

THE ROBINSON DUSTING AND SPRINKLING MACHINE.—Several machines have been patented that apply the powder by means of revolving perforated cylinders. The oldest of these seems to be one invented by Mr. William T. Robinson of Huntsville, Tex. (Patent No. 146205, January 6, 1874). It combines both sprinkling and dusting, in that pure water is sprinkled over the plants by an arrangement in front of a two-wheeled truck, while at the same time the powdered poison is dusted from revolving cylinders attached to the rear part of the truck. The powder thus sticks to the leaves and may be applied at all hours of the day. Both the duster and the sprinkler can be detached at will and used separately if necessary.

From the accompanying Figs. 43 and 44, the former of which is a plan view, the latter a longitudinal sectional view of the machine, it will be seen that the dusting apparatus consists of an horizontal shaft *G*, extending each way beyond the wheels, for reaching over the outside rows, and carrying three or more revolving screens of sieves, *H*, for sprinkling on powdered substances. Said shaft is mounted on the rear end of the frame *I*, which is jointed to the truck at *J*, and suspended from the frame *M* by ropes *L*, which are wound upon the shaft *N*, or let out from it, to shift the screens according to the height of the plants. The shaft is revolved by a belt, *O*, from one of the wheels of the truck, working on cone-pulleys *P O*, for varying the speed of the screens or sieves, as may be required. The pulley *O* on the shaft *G* connects with it by a

clutch, R, which is connected with a shifting-lever, S, for throwing the shaft out of gear when turning around at the end of the rows, to save waste of material. T is a box for carrying the stock of powder, from which to replenish the screens or sieves, as

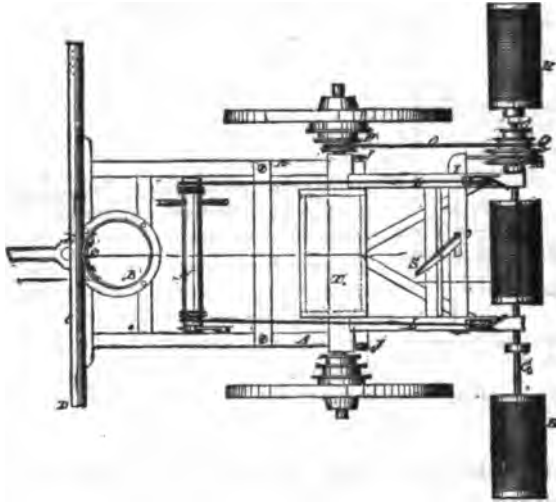


FIG. 43.—THE ROBINSON COMBINED DUSTER AND SPRINKLER: plan view.

they become exhausted from time to time. This box may be also used for a seat for the driver. The sieves are supplied through an opening in the ends, which may be closed by a gate or door of any kind, or by an opening in the side similarly closed.

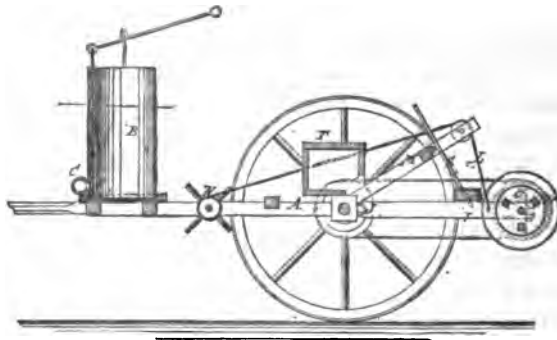


FIG. 44.—THE ROBINSON DUSTER AND SPRINKLER: longitudinal section.

THE DAVIS DUSTER—Invented by Mr. Nicholas A. Davis, of Busk, Tex. (patent No. 154651, September 1, 1874.) This is almost an exact counterpart of the foregoing machine, but without the sprinkling attachment. The only peculiarity is the addition of springs to the revolving cylinders to prevent too great a discharge of the poison in case of a sudden jar.

In the accompanying drawings Fig. 45 represents the invention attached to a cart. Fig. 46 is a cross-section through the line *y y*.

A represents an ordinary farm-cart, across the rear end of which is secured the horizontal shaft B, having its bearings in the arms *c c*, projecting behind the cart. On the shaft B are placed two or more loosely-revolving perforated cylinders, E, being revolved upon the shaft, which carries a pulley, *a*, over which a band or cord works, passing to the hub of the cart-wheel, from which it receives motion, and thus causes the shaft B to revolve when the cart is in motion. Attached to the inner end of each of the outside cylinders is a spiral spring, *b*, coiled around the shaft A, and so arranged as to secure an easy, gentle, lateral motion to the cylinders in case of a sudden jar given the machine. A similar spring may be used at the opposite end of the cylinders, so as to check the jar in both directions. This invention can be fixed to any kind of frame moving on wheels, and by a hand-crank and ordinary cog-gearing be successfully worked.

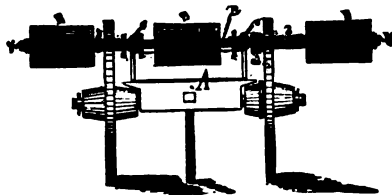


FIG. 45.—THE DAVIS DUSTER: attached to cart.



FIG. 46.—THE DAVIS DUSTER: longitudinal section.

THE LEVY DUSTER.—This duster, patented by Mr. Charles H. Levy, of Natchitoches, La. (No. 154690, September 1, 1874), also distributes the poison by means of revolving cylinders which can be adjusted to the height of the plant. The whole apparatus can be secured to the forward part of a saddle as well as to any cart. Fig. 47 is a front view of this contrivance, and Fig. 48 a side view of the same, partly in section through one of the cylinders.

AA are two cylinders, formed by attaching fine wire-gauze or finely-perforated sheet metal to circular ends or disks. To the inner surfaces of the cylinders A are attached longitudinal strips B, to one side of each of which

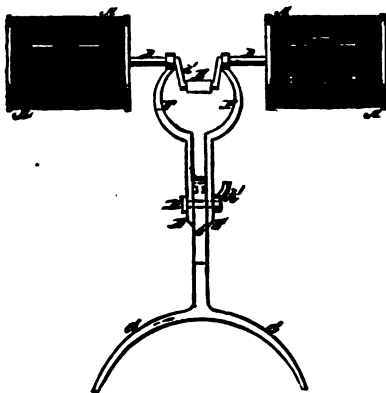


FIG. 47.—THE LEVY DUSTER: front view.

is attached a strip, C, of tin or other suitable sheet metal, which strips thus form flanges, which, as the cylinders revolve, raise the compound and allow it to fall back so as to keep it stirred up and prevent the heavier ingredients from settling and thus escaping in too large a proportion and unevenly. The cylinders A are placed upon the end parts of a shaft, D, and are secured in place adjustably by keys or nuts, so that they may be moved toward or from each other to correspond with the distance apart of the rows of plants. Upon the middle part of shaft D is formed a crank, *d'*, by means of which the cylinders are revolved, either by taking hold of the said crank *d'* directly, or by a short handle, E, pivoted to said crank. The shaft D revolves in eyes in the upper ends of two bars, F, the upper parts of which are curved to give room for the crank *d'* to operate. The lower parts of the bars F are parallel with each other, and pass down upon the opposite sides of the standard G, to which they are secured by a bolt, H, which passes through a hole in the lower parts of the said bars F, and through a slot in the said standard G, so that by loosening the hand-nut *N'* of the bolt H the cylinders A may be raised and lowered, as the height of the cotton-plants may require.

is attached a strip, C, of tin or other suitable sheet metal, which strips thus form flanges, which, as the cylinders revolve, raise the compound and allow it to fall back so as to keep it stirred up and prevent the heavier ingredients from settling and thus escaping in too large a proportion and unevenly. The cylinders A are placed upon the end parts of a shaft, D, and are secured in place adjustably by keys or nuts, so that they may be moved toward or from each other to correspond with the distance apart of the rows of plants. Upon the middle part of shaft D is formed a crank, *d'*, by means of which

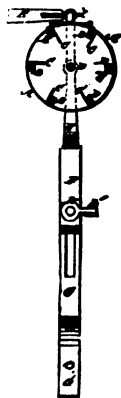


FIG. 48.—THE LEVY DUSTER: side view.

The bars F may be kept from turning upon the bolt H by lugs formed upon the inner sides of the bars F, which enter the slot of the standard G, or by a second bolt.

The lower end of the standard G is branched, and has screw-holes formed through said branches to receive the screws or bolts by which the machine is secured to the forward part of a saddle, or to the frame of a sulky.

THE TAYLOR DUSTING AND SPRINKLING MACHINE.—Another machine, invented by Mr. Thomas B. Taylor, of Mount Meigs, Ala. (patent No. 214205, April 8, 1879), is somewhat similar to the Robinson machine already described in that it has arrangements for both sprinkling liquids and for dusting powders, and both can be used simultaneously or each separately. The dusting apparatus does not differ materially from the perforated revolving cylinders already described, but the machine is interesting because it is to be attached to a common plow-stock, so as to do the cultivating and the poisoning at one and the same time. Fig. 49 is a vertical longitudinal section, and represents the plow-stock with both the sprinkling and dusting arrangements attached to the same.

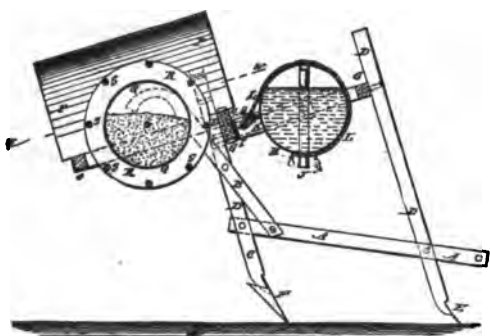


FIG. 49.—THE TAYLOR DUSTING AND SPRINKLING MACHINE.

A represents the beam, B the handles, and C the standard of an ordinary plow-stock. To the forward and rear parts of the beam A are rigidly attached two standards, D, the rear one of which may be the upward extension of the plow-standard C. The lower end of the forward standard, D, extends to or nearly to the ground, and has a plow-plate, E, attached to it to assist the plow-plate F attached to the plow-standard C in cultivating the ground, and to give steadiness to the machine, so that it may be readily controlled. To the upper parts of the standards D are pivoted the centers of the long front and rear bars of the rectangular frame G to the centers of the short side-bars, of which are pivoted the ends of the sheet-metal cylinder H. This cylinder represents the sprinkler, and a more detailed description of it will be given under the proper head. It can be detached, and the dusting arrangement which, in the figure, is represented as secured to the rear of the frame G can be put in its place. This dusting arrangement consists of a frame, O, similar to G, and to it are secured two semi-cylindrical plates, P, with their convex sides upward, and with their inner side edges near and upon the opposite side of the handles B. In bearings in the opposite sides of the two plates P revolve the journals of two cylinders, Q, made of finely-perforated sheet metal or fine wire-gauze to sift the dry powder poison upon the plants.

The sifting-cylinders Q are designed to be revolved by contact with the plants. The ends of the cylinders Q are provided with ring-flanges R, to which are attached the ends of a number of rods, S, to strike against the plants and revolve the said cylinders. The rods S prevent the surfaces of the cylinders from being wet by moisture from the plants, which would cause the powder to stick to them and thus clog the discharge-holes.

The two sifting-cylinders, as well as the sprinkler, project of course on each side of the plow and distribute the poison on the two adjacent rows between which the plow is drawn.

THE ALLEN DUSTER.—Invented by Mr. Samuel L. Allen, of Philadelphia (patent No. 178704, June 13, 1876). This machine applies the powder by means of a pair of bellows mounted on wheels.

THE YOUNG DUSTER.—Invented by Mr. James W. Young, of Southfield, Mich. (patent No. 188219, March 6, 1877). This is an apparatus carried across the shoulders of a person between two rows of cotton. The poison is applied by means of perforated cylinders which are set in motion by the bearer by means of crank-handles.

THE GOODHEART DUSTER AND SPRINKLER.—This machine, invented by Mr. James Goodheart, of Matawan, N. J. (patent No. 204720, June 11, 1878), works on the same principle as the Taylor and Robinson machines. The dusting apparatus consists of a box with a screen bottom, the whole being agitated by means of a lever connected with one of the wheels. The sprinkler consists of a transverse pipe with a number of holes at its lower forward side. The machine is drawn over but one row of plants.

Machines and Contrivances for sprinkling or spraying.

For the sake of convenience the contrivances for the use of liquid poisons are here divided into those intended to be used on a small scale, covering one or two, rarely three, rows of cotton at once, and those that can be used to advantage on large fields and which cover from three to nine rows or more at once. In the first class the liquid is distributed by its natural pressure as in a garden sprinkler, while in the second class, or those intended to be used on large fields, there is always a pump, which supplies the pressure necessary to produce and throw the liquid upon the plants in the form of spray. Several of the machines here described do very good work in the field, and are strongly to be recommended. Their principal disadvantage lies in the fact that in wet weather it is often impossible to use them in a field on account of their weight. One great desideratum of any horse-sprinkler should, therefore, be lightness, and the machine which most combines lightness with cheapness and ease of management will naturally be most sought for.



FIG. 50.—GRAY'S IMPROVED SPRINKLER.

THE GRAY SPRINKLER.—For applying the liquid poison to the leaves of the plants a common watering-pot will be found to do good service on small patches of cotton. Still better for small fields is the sprinkler constructed by Mr. Frank M. Gray, of Jefferson, Ill., for sprinkling two rows at once. (Fig. 50.) It consists of a can, capable of holding about eight gallons of liquid, and so formed as to rest easy on the back, to which it is fastened, knapsack-fashion, by adjustable straps, which reach over the shoulders and fasten across the breast. To the lower part of the can are attached two rubber tubes, which are connected with two nozzles or sprinklers. The inside of the can has three shelves, which help to keep the mixture stirred. There is a convenient lever at the bottom which presses the tubes and shuts off the outflow at will, and two hooks on the sides near the top, on which to hang the tubes when not in use. On the top is a small air tube and a capped orifice.

THE RUGGLES SPRINKLER.—Invented by Mr. Silas Ruggles, of Three Rivers, Mass. (patent No. 203072, April 30, 1878), is an exact counterpart of Gray's Sprinkler, with the addition of a stirrer, agitated by the movement of the arm of the bearer.

THE RAMSEY SPRINKLER.—Mr. Croghan A. Ramsey, of Schulenburg, Tex., has obtained a patent (No. 163526, May 18, 1875) for the very simple contrivance which is illustrated at Fig. 51. It consists of a box

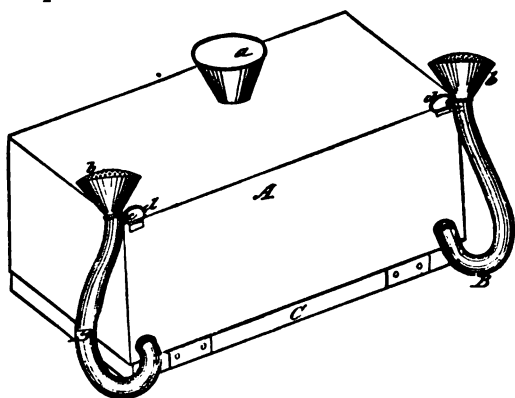


FIG. 51.—THE RAMSEY SPRINKLER.

or vessel, A, large enough to hold about five gallons. It is provided at its top with a receiving funnel, *a*, for the liquid. At the bottom or on the front side near the bottom, and near each end, are two flexible tubes or rubber hose, B, provided with nozzles, *b*. This device is intended to be strapped upon a horse's back, to the cantle of a saddle, with the tubes in front. The front of the

vessel A is inclined backward, so as not to interfere with the movements of the rider; and a pad, C, may be placed under it, so as to cause it to rest easy upon the horse. The nozzles, when not in use, are held above the top of the box by means of hooks, *c*, which seize over rings, *d*, upon the top corners of the box, so as to prevent the liquid from flowing out. When in use, the rider takes a tube in each hand and proceeds to sprinkle the rows on each side.

The sprinkling apparatus of the Taylor Dusting and Sprinkling Machine described and figured on p. 83 should be mentioned in this connection. The accompanying Fig. 52 gives another representation of this machine, but with the dusting arrangement detached. Leaving out

those parts that have been already described, this sprinkling apparatus may be explained as follows:

The letter I represents a metal strap, attached to the rear bar of the frame G, with the end parts bent forwards at right angles and with holes to receive the journals of the cylinder H, the arms of the strap thus serving as springs to keep the cylinder in place. By a simple arrangement, indicated in the figure, the frame G may be adjusted higher or lower to the standards D, according to the height of the plants. In the upper side of the cylinder H are formed a number of small holes, through which the liquid poison escapes to the plants. In the center of the perforated side of the cylinder H is formed a hole in which is secured the tube J, through which the poison

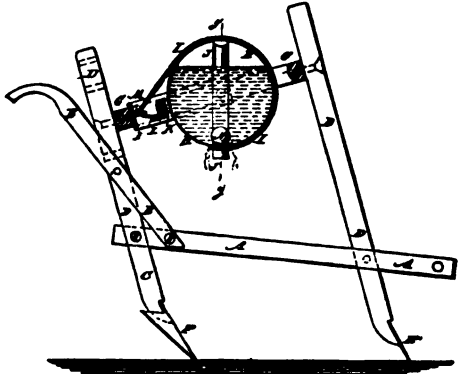


FIG. 52.—THE TAYLOR SPRINKLING APPARATUS.

is poured into the said cylinder. The inner end of tube J is soldered in part to the inner surface of the opposite side of the cylinder H to prevent it from being loosened by the pressure of the liquid. In the sides of the inner end of the tube J are formed holes of such a size that the liquid will readily pass out of the said tube into the cylinder H. To the rear side of cylinder H are attached loops, K, to which are attached cords, L, which pass through eyes, M, or around pulleys attached to the rear bar of the frame G. From the eyes or pulleys M the cords L pass over the cylinder H, and are attached to the projecting end of the tube J. The cords L serve to secure the cylinder H in place and limit its movement when turned upon its journals. One or more balls, N, may be placed in the cylinder H, which, when the cylinder becomes empty, make a noise, and thus notify the operator.

If desired, the cylinder H may be rigidly secured to a single bar, G, attached to a single standard, D. In this case holes must be formed also in the upper side of the cylinder H. The holes in the upper side let the air escape in filling, and admit air to cause the liquid poison to flow out through the lower holes. This construction is a little simpler and cheaper than the other, but causes a slight waste of the poison, as some of the poison will flow out through the lower holes while the cylinder is being filled.

The operator may be protected from the poisonous liquid by cloth screens placed upon the opposite sides of the handles B, and attached at their upper and lower edges to two pairs of rearwardly projecting bars attached to the frame-work of the machine.

The sprinkling apparatus mentioned in connection with the Robinson Dusting and Sprinkling machine, described and figured on p. 77, consists of a tank, B, for holding the liquid, and of a sprinkling tube, C, connected with the tank and extending across the frame and beyond far enough to reach the two outside rows. This tube has small perforations, D, at the ends, and also at the middle, E, for sprinkling the liquid upon three rows of cotton. A gate or valve, F, is arranged in the tank to shut off the liquid from the tube or to regulate the discharge. The end of the tube is to be closed with a cap or plug, so that it can be opened and the perforations be cleaned out.

THE TOWNSEND SPRINKLER.—This was invented by Mr. George Townsend, of Greenville Centre, N. Y. (patent No. 212412, February 18,

1879), and is intended, like Gray's Sprinkler, to be carried on the back of a person. It consists of a tank, with a stirring arrangement, but has only one sprinkling tube, and sprinkles, therefore, only one row of plants.

THE WILLIE SPRINKLER—Invented by Mr. Wm. T. Willie, of Independence, Tex. (patent No. 158345, December 29, 1874), sprinkles two rows of cotton by means of an arrangement very like a common garden sprinkler, one of which is secured on each side of a frame fastened across a saddle.

THE SCHANCK SPRINKLER.—This sprinkler, invented by Mr. Lafayette S. Schanck, of Marlborough, N. J. (patent No. 215683, May 20, 1879), consists of the barrel with a stirring apparatus and with two or more pipes connected with the bottom of the barrel, each having a finely perforated nozzle. The whole apparatus is placed on a cart.



FIG. 53.—PECK'S SPRAY MACHINE.

PECK'S SPRAY MACHINE.—A very good portable spray machine has been invented by Mr. W. P. Peck, of West Grove, Pa. (Fig. 53) consisting of a tank strapped knapsack-fashion on the shoulders, and connected by rubber tubes with a pair of bellows, buckled to the waist, turned by a crank, and connected with a movable nozzle. The tank holds three gallons, and there is a simple device at the bottom, which, by the motion of walking, keeps the liquid in agitation and prevents the poison from settling. The liquid issues in a fine spray and with considerable force.

Mr. Charles T. Hurd, of Victoria, Tex., whose machine for dusting has been described and figured on p. 76, Fig. 40, suggests in his claim that

by changing the oscillating screen *b*, and inserting a perforated bottom in the box *A*, and charging the same with poisonous liquid, the latter may be atomized by the current of air originated by the blower, and thus applied to the row of plants over which the apparatus is drawn.

It is evident that these devices, while useful in a small way, are insufficient for large fields. Whenever it becomes necessary to protect the cotton, success often depends on the rapidity with which the work can be done; else the worms may totally destroy parts of a plantation before the planter manages to prevent it. Hence the importance of machines which apply the remedy to several rows at once.

Before describing these machines, it may be mentioned that the FOUNTAIN PUMP, manufactured by Mr. Josiah A. Whitman, of Providence, R. I., has been extensively used in the South for applying liquid

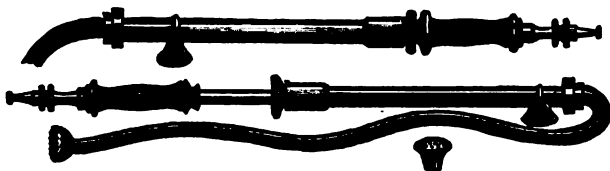


Fig. 54.—FOUNTAIN PUMP.

poison. These fountain pumps (Fig. 54) are too well known to need any further description. They are sold in the South for about \$10 apiece, including the rubber hose. The most common mode of using them is the following: A barrel containing the liquid is put on a cart or wagon and drawn over the field. One hand is employed, if necessary, to keep the poison stirred up, while three others, each with one of these pumps, apply the liquid from the rear of the wagon, one taking charge of the three inner rows, the others each about three more rows on either side. In the use of this and of all other pumps it is advisable to add a strainer to the lower end of the hose in order to prevent impurities from entering the valve. In an emergency, where no machines are at command, these fountain pumps do excellent service, and many prefer them to other means of applying the poison. They are, however, wasteful of material, and the poison is more apt to get on to the bodies of those employed in their use than in most of the other modes of sprinkling.

Most of the machines used for throwing liquid on a large scale, whether patented or not, are modifications of one and the same idea and principle, viz, a barrel or other vessel to contain the liquid, a vehicle to carry it, a force-pump firmly secured to the top of the barrel, and a distributing nozzle, or several of them, connected with the discharge-pipe. The differences they exhibit are found principally in the nature of the distributors, the most successful ones being those which least clog, since it is almost impossible to get such pure water that there will not be some clogging material, even where strainers are used.

THE GOODIN SPRINKLER.—This machine, invented by Mr. James L. Goodin, of Montgomery, Tex. (patent No. 198014, December 11, 1877), is represented by the accompanying cuts. Fig. 55 is a top view, and

Fig. 56 a side view of the same. The letter A represents a tank or any other vessel to receive the poisoned liquid.

In the lower part of the forward end of the tank A is secured a discharge-pipe, B, the inner end of which is provided with a valve or ordinary sirup-faucet. The stem C of the valve or faucet passes up through a hole in the top of the tank A, and its upper end is pivoted to the end of a lever, D, which is

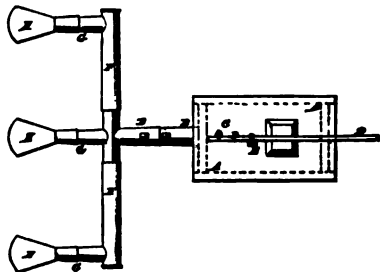


Fig. 55.—THE GOODIN SPRINKLER: top view.

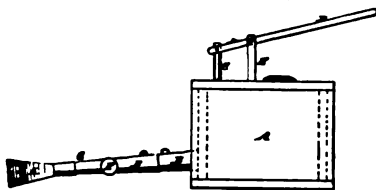


Fig. 56.—THE GOODIN SPRINKLER: side view.

pivoted to a short standard, E, attached to the top of the tank A.

To the forward end of the pipe B is attached a cross-pipe, F, from the forward side of the center and ends of which project short pipes, G, having heads, H, attached to their forward ends. The heads H are perforated with numerous small holes. The pipes BF are jointed as shown in the drawing, so that they may be lengthened or shortened as circumstances may require.

THE YEAGER SPRINKLER.—This is a sprinkler invented by Mr. George Yeager, of Flatonia, Tex. (patent No. 204410, May 28, 1878). Fig. 57 is a part sectional side view, and Fig. 58 a plan view thereof.

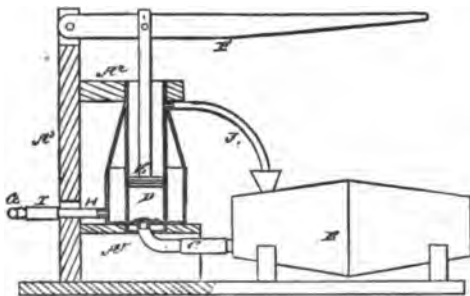


FIG. 57.—THE YEAGER SPRINKLER: side view.

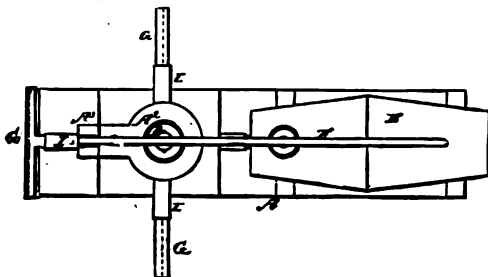


FIG. 58.—THE YEAGER SPRINKLER: top view.

It consists of a platform, A, upon which is laid a barrel, B, containing the poisonous liquid. A rubber hose, C, connects this barrel with the bottom of a pump-cylinder, D. This cylinder is supported on a step, A¹, and its upper end held in a brace, A², attached to a standard, A³, which rises from the platform A. E is the pump-plunger, connected to a lever, F, which is pivoted in the upper end of the standard A³. The liquid poison is forced out through the sprinklers G G G, which are three in number, and throw the water in a fine mist over three rows of cotton. A rubber hose, I, is attached to each of the spouts H of the pump to form connection with the sprinklers G, for the purpose of lengthening or shortening the spouts, especially the two on opposite sides of the pump, and of detaching and cleaning the sprinklers. The upper end of the pump-cylinder is left open and a spout or tube, J, is connected thereto to conduct the liquid, which would otherwise be wasted, back into the barrel.

The connection of this waste-pipe with this machine is the only point which is claimed as new by the inventor. The sprinklers or nozzles are

not further described, but it is to be understood that the spray is produced in the same way as described in this class of sprinklers.

THE RUHMANN SPRINKLER.—Invented by Mr. Julius P. Ruhmann, of Schulenburg, Tex. (patent No. 206901 August 13, 1878). This does not differ in any essential respect from the machines just described.

Fig. 59 is a longitudinal section of the machine; Fig. 60 shows the connection of the pump-cylinder with the air-chamber; Fig. 61 represents the strainer; Fig. 62, the nozzle, showing the arrangement for cleaning the same; and Fig. 63 shows a modification of the discharge-pipe.

The letter *a* prerepresents the reservoir for holding the poisonous liquid; *b* is the pump-cylinder, in which the piston *c* is worked up and down by means of the lever *d*. The lower end of this cylinder is made funnel-shaped, and to it is fastened the rubber tube *e* which connects it with the strainer *f*. This strainer is made in two parts for the introduction of a straining-cloth, *g*, and for convenience in cleaning. The lower end of the strainer is perforated, and, if desired, any additional straining matter may be placed between the perforated bottom and the cloth, so as to make sure that no substances shall be forced into the sprinkler to clog its action. To the lower end of the cylinder is secured the discharge-pipe *h*, upon the top of which is formed the air-chamber *i*. Upon the outer end of the discharge-pipe is placed the sprinkler *l*, which is round and flat, as shown, and perforated about one-half around. Upon the top of this sprinkler is screwed the cap or cover *m*, secured to which is the brush *n*. The handle of the brush is bent at right angles, as shown, and is secured to the cap in such a manner as to form, as it were, a part thereof, so that as the brush is moved around to clear away any obstructions which may have a tendency to close up the fine perforations in the edge of the sprinkler the cap turns with it. By means of this screw-cap the brush can be adjusted up and down at will, so that after cleaning off the perforations the brush can be depressed down below the level of the holes, so as to be out of the way.

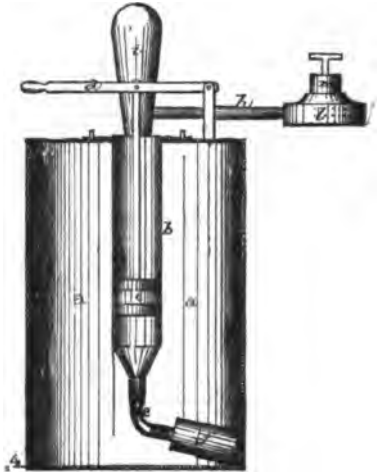


FIG. 59.—THE RUHMANN SPRINKLER: longitudinal section.

The letter *a* prerepresents the reservoir for holding the poisonous liquid; *b* is the pump-cylinder, in which the piston *c* is worked up and down by means of the lever *d*. The lower end of this cylinder is made funnel-shaped, and to it is fastened the rubber tube *e* which connects it with the strainer *f*. This strainer is made in two parts for the introduction of a straining-cloth, *g*, and for convenience in cleaning. The lower end of the strainer is perforated, and, if desired, any additional straining matter may be placed between the perforated bottom and the cloth, so as to make sure that no substances shall be forced into the sprinkler to clog its action. To the lower end of the cylinder is secured the discharge-pipe *h*, upon the top of which is formed the air-chamber *i*. Upon the outer end of the discharge-pipe is placed the sprinkler *l*, which is round and flat, as shown, and perforated about one-half around. Upon the top of this sprinkler is screwed the cap or cover *m*, secured to which is the brush *n*. The handle of the brush is bent at right angles, as shown, and is secured to the cap in such a manner as to form, as it were, a part thereof, so that as the brush is moved around to clear away any obstructions which may have a tendency to close up the fine perforations in the edge of the sprinkler the cap turns with it. By means of this screw-cap the brush can be adjusted up and down at will, so that after cleaning off the perforations the brush can be depressed down below the level of the holes, so as to be out of the way.



FIG. 60.

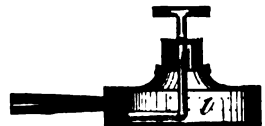


FIG. 62.



FIG. 61.



FIG. 63.

RUHMANN'S SPRINKLER: parts referred to.

Instead of a single nozzle, there may be two or more used by simply changing the construction of the discharge-pipe, as in Fig. 63, which represents one made for the use of three nozzles.

Several other machines of this class have been patented, but as they are mere repetitions of those already described, and the patents have been obtained on slight changes in the pump and in the arrangement for cleaning the nozzles, it is sufficient to merely mention those that have come to my knowledge. Mr. J. C. Melcher, of Black Jack Springs, Tex., has constructed one, and obtained a patent for the nozzle January 18, 1879. It is of the same shape as that of Mr. Ruhmann, but without the brush, and the cleaning is done by unscrewing the upper cover of the nozzle. Another of very similar nature is the improved sprinkler of Mr. G. Jeager, of Flatonia, Tex., for which a patent was applied for last April.

If the pump of these machines is made of good material, so as to give and stand a good deal of pressure, and if the nozzle is of sufficient size, or if several smaller nozzles are used, a fine and efficient spray can be thrown over from five to seven rows of cotton when the wind is favorable. In this way about 40 acres can be sprinkled in one day. The price of these machines ranges from \$6 to \$9, and they do good work, the principal difficulty being found in keeping the nozzles clean.

THE JOHNSON SPRAY MACHINE.—This sprinkler, invented by Judge Jehu W. Johnson, of Columbus, Tex. (patents No. 145571, December 16, 1873, and No. 145572, of the same date), is not only the oldest one on record for the application of liquid poison on a large scale, but produces the spray in a novel and peculiar manner.

The accompanying sketch represents this machine in operation. It will be seen therefrom that it consists of a tank placed upon a two-wheeled cart. The pump secured to the top of the tank is a common double-acting force pump, and with the discharge-pipe is connected a transverse pipe. These parts need no further description, and nothing new or peculiar is claimed for them. The claim for the second patent mentioned above is based upon the addition of a self-acting pitman, the arrangement of which can be seen in the sketch, and which is more fully illustrated at Fig. 65. The letter A represents the tank, B the platform of the cart, which is provided with the two wheels, C. These are much smaller than ordinary cart-wheels, in order to give the required number of revolutions necessary to the successful operation of the pump. In order to place the cart-bed at such an elevation as to pass over the rows of plants, it is raised by means of vertical bars, as will be seen in the sketch. One of the wheels C has a crank-pin, c, attached to it, at a suitable distance from the center, and to this crank-pin is attached the lower end of a pitman, the upper end of which is attached to the pump-lever G. The discharge-pipe of the pump is provided with a valve to regulate the flow of the liquid. With the transverse pipe before mentioned are connected, by means of screw-joints, branch pipes K, which in the sketch and in the diagram are five in number.

These branch pipes are made of cast metal, and on their inner surface, at the lower end, grooves, l, are formed, either during the process

of casting or by planing or cutting them out afterwards. In the lower end of these branch-pipes a plug made of rubber or cork is inserted, and a rod extends from the plug to the upper end of the tube *k*, where

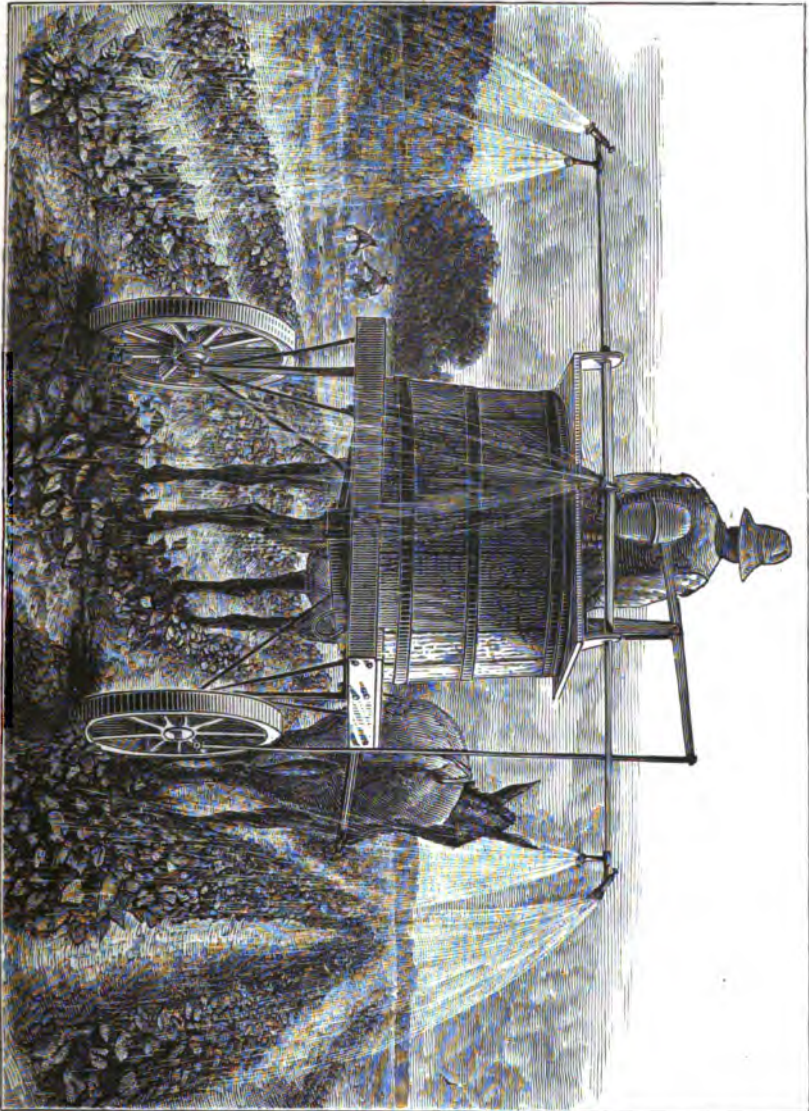


FIG. 64.—JOHNSON SPRAY MACHINE: in action.

it engages with a nut by which the plug may be tightened or loosened. It will be seen that the liquid passing through this pipe must escape by way of the grooves and assume the form of spray, and that by tightening or loosening the plug the size of the grooves is increased or diminished.

This machine makes a remarkably fine spray, but it possesses the same disadvantage as those already mentioned, namely, the ease with which the nozzles clog, notwithstanding the receiving-pipe of the pump is provided with a strainer.

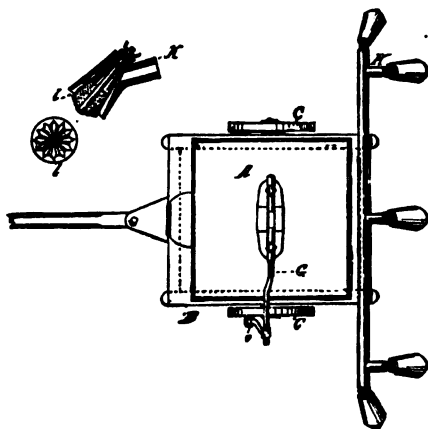


FIG. 65.—JOHNSON'S SPRAY MACHINE: top view.

This I found to be a serious drawback, requiring frequent stopping of the driver and his dismounting to remove, cleanse, and readjust the plugs. The addition of the self-acting pitman has proved less useful than one would suppose, for Judge Johnson himself writes me that "experience has demonstrated the fact that it is about as easy and far more economical to work the pump by hand-power than to use the pitman rod." By dispensing with it, the tank may be placed on any cart without special construction. This machine has been considerably used, but its price (\$65 without the cart) is very high when compared with that of others here described.

The following machines produce the spray on a quite different principle and one much better calculated to prevent clogging. They are all recently invented, and by virtue of their decided advantages will, in my judgment, supersede those hitherto mentioned. They do not clog up; they distribute the spray over more rows of cotton, and they are simpler in construction and cheaper.

THE WARNER SADDLE SPRINKLER.—A device very well spoken of and advertised as the saddle sprinkler has been perfected by Mr. Jackson Warner, Austin, Tex. The liquid is contained in a bag which is used on the back of a mule or horse as a saddle, the liquid being forced out by the action of the feet. I have not been able to see either the contrivance or any specification of it.

THE BINKLEY ATOMIZER.—This sprinkler, invented but not patented by Mr. J. N. Binkley, of Columbus, Tex., and herewith illustrated, is one of the simplest and yet one of the best in use. Fig. 66, A, represents it in operation with a part of the pump. This pump is the usual double-acting force-pump secured to the top of a barrel containing the liquid. The letter *a* represents the pump cylinder, *b* the air chamber, and *c* a transverse tin pipe connected with the discharge pipe of the pump and having four of the atomizing nozzles. Fig. 66, B, shows a side view of the atomizer on a somewhat larger scale. A conical tin piece, *d*, is soldered to the pipe *c*, having at its end an orifice much larger than the fine perforations of the previous machines described. A circular tin plate, *e*, is soldered to the lower side of the cone *d*, so that the jet of water, issuing with great force from the orifice, strikes the plate at an obtuse angle

and is scattered in very fine and far reaching spray. The large orifice permits smaller objects to be thrown out with the jet, larger objects being prevented by a strainer from entering the pump, while by a slight bending of the distributing-plate, so as to bring it at more acute angles with the nozzle, the spray may be thrown more and more upward. The whole machine is very light and simple and easily made by any tin-smith at comparatively trifling cost. The principal drawback to it as

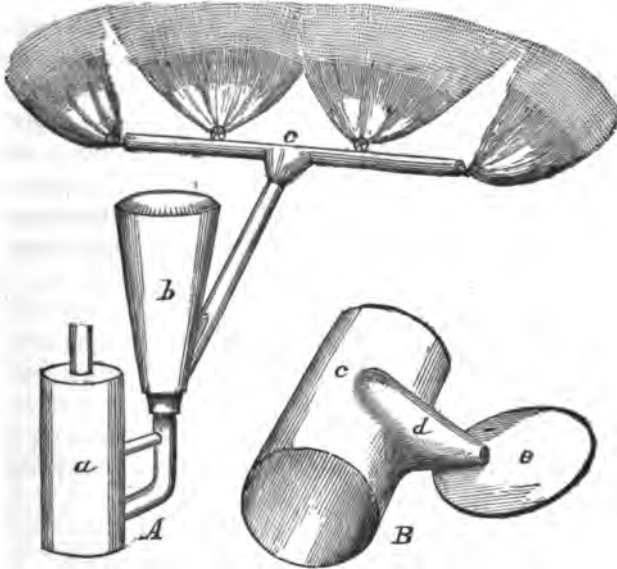


FIG. 66.—THE BINKLEY ATOMIZER.

at present constructed by Mr. Binkley is that it is made in one piece, so that in case a larger object obstructs the orifice there is some difficulty in removing the same.

This defect could be easily remedied by making the cone in two pieces, the nozzle itself to be screwed on to the basal or soldered piece. The plates and the orifices should be thoroughly cleansed and dried after use, in order to prevent rusting. The machine with four spouts, as in the figure, throws the spray over six or seven rows, but its capacity is easily increased by lengthening the transverse pipe (c). Its cost is less than \$10.

After witnessing this machine in operation, I am satisfied that the atomizing principle is a most valuable one, and that with modified conducting pipes or tubing, so as to throw the spray from near the ground up into the plants and on the under surface of the leaves, as in Mr. Daughtrey's machine (see p. 94), it will give great satisfaction because of its cheapness and simplicity.

THE SCHIER ATOMIZER.—This atomizer was recently perfected by Mr. John Schier, of Ellingen, Tex., and is on the same general principles as the preceding. For the spraying arrangement proper a patent

was obtained October 2, 1879. In the accompanying illustration (Fig. 67) it is represented in operation, attached to a small hand-pump such as is commonly used throughout the country. The pump is to be con-

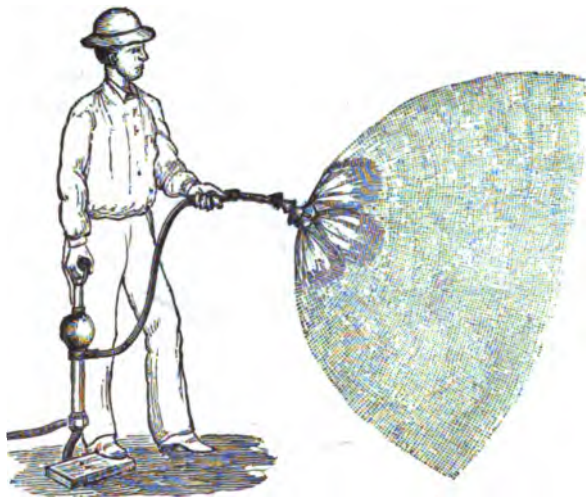


FIG. 67.—THE SCHIER ATOMIZER.

nected by a hose with a vessel containing the liquid, and the whole machine to be operated from the rear part of a cart drawn through the field. At Fig. 68 I have given an enlarged view of the atomizer and mode of attachment, and at Fig. 69 the same with the distributing-plate disconnected, so as to show the mode of adjustment.*

The nozzles *c c c* are connected with the conducting pipe (*a*) by means of a nut (*b*), and throw the liquid on to a distributing-plate (*d*) of brass, backed and strengthened by an outer layer of tin. This plate is secured

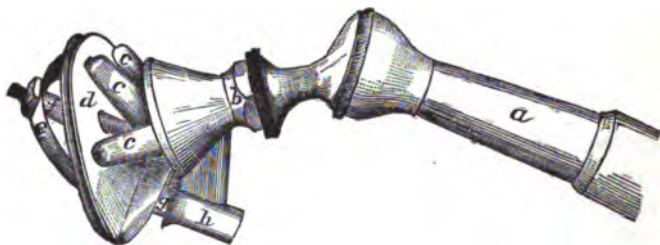


FIG. 68.—THE SCHIER ATOMIZER: nozzle and distributor connected.

in place by means of a screw soldered beneath the nozzles, running through a tube connected with and rendered firm by a bow (*e*) soldered at each end to the outer layer of the plate. The screw issuing from this

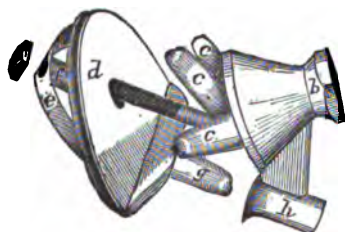


FIG. 69.—THE SCHIER ATOMIZER: nozzle and distributor disconnected.

of an ordinary pin. This sprinkler can be operated either as shown in

*Mr. Schler writes that in his sprinkler, as it is patented, there is an additional arrangement for conducting back the liquid that drips from the plate.

Fig. 67 or fastened to a frame on a cart. When the distributor is held down the spray is directed upward, and it can therefore be used for spraying the under side of the leaves.

The peculiarity of this machine consists in the fact that with an exceedingly small and light instrument an efficient spray can be produced that reaches over five rows of cotton, the strength of the distributing apparatus being such as to warrant great concentration of pressure. The contrivance may be considerably simplified, and Mr. Schier, who calls his atomizer the "Diana Cotton Sprinkler," is now perfecting a machine that will supply three of these atomizers and cover sixteen rows of cotton at once, so that in one day from 150 to 200 acres may be poisoned.

RUHMANN'S IMPROVED ATOMIZER.—For his improved sprinkler, a patent of which has been applied for, Mr. Ruhmann uses the same pump and tripartite discharge-pipe already described and figured (Figs. 63 and 70a), and the improvement consists in an entirely new arrangement for producing the spray. In Fig. 70,

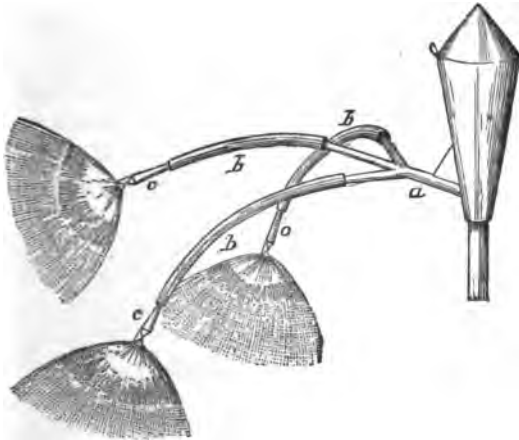


FIG. 70.—RUHMANN'S IMPROVED ATOMIZER: in operation.

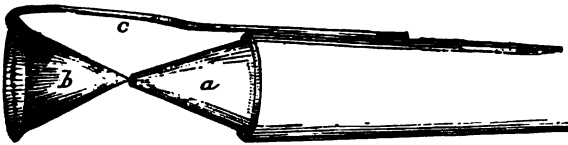


FIG. 71.—RUHMANN'S IMPROVED ATOMIZER.

and somewhat funnel-shaped, in order to fit tightly in the rubber tube. To the anterior end of this pipe is soldered a conical nose, *a*, having an orifice of about the size of an ordinary pin-head, or large enough to prevent clogging by minute obstacles, larger ones being prevented from entering the pump by the strainer connected therewith (Fig. 61). Opposite this orifice, and almost touching it, is the point of another conical, hollow piece, *b*, with a slightly dilated or recurved rim, and held in position by a stout wire, *c*, soldered on to its edge and to the side of the tin pipe. The liquid, issuing with great force from the orifice, strikes the

point of the hollow cone, and is carried in all directions along its sides, when, by striking the bent rim, it is scattered in a bell-shaped spray.

With these three atomizers the spray may be distributed over seven rows in calm weather, and over nine rows if the wind be favorable. The price of the machine, including the pump, is \$7.50. This form of sprinkler has also the advantage that it may be used to distribute the liquid from below. For this purpose the rim of the distributor should be bent back so as to form a more acute angle. Other changes necessary for this purpose have already been indicated in treating of previous machines.

There is no doubt but that these three atomizers last described are all valuable as embodying a simple principle which may be made use of at comparatively little cost, and both to throw the spray on to the plants above or up among them from below. That they have, in these respects, a decided advantage over all the other contrivances mentioned will admit of no doubt.

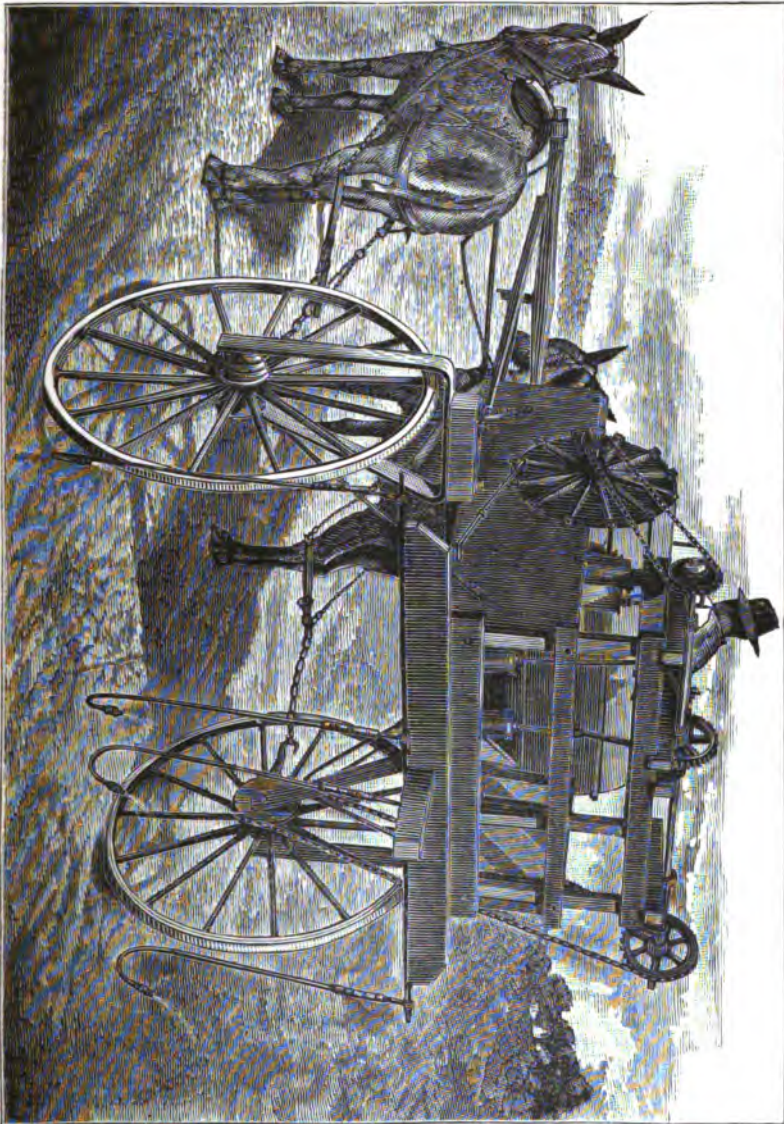
THE DAUGHTREY ATOMIZER.—There still remains one machine to be described in this connection which is highly interesting for several reasons: 1st, because it is the only one actually in use for the distributing of the liquid from below; 2d, because the construction of the pump is quite peculiar; and, 3d, because the arrangement for producing the spray is not only entirely different from any described in the foregoing pages, but also most simple. This machine was invented by Mr. William J. Daughtrey, of Selma, Ala. (patent No. 200376, February 19, 1878). The accompanying sketch (Fig. 72) represents it as it appears. It consists in the main of a pump, which is made self-operating by means of a pulley, and which forces air into the receiving tank and into a compression cylinder connected therewith, thus supplying the pressure necessary for the production of the spray. As will be seen from the sketch, a transverse distributing pipe is connected with a number (four in the sketch) of vertical pipes recurved at the ends, which receive the nozzles, one of which is represented in section in the accompanying Fig. 73. The nozzle *N*, which is screwed onto the pipe, has a closed end, *n*, provided with two openings, *n*¹, oppositely inclined, so that the jets delivered through them meet at a point near *n* and deflect and disperse each other so as to form an extremely fine spray. The openings *n*¹ are large enough to avoid being obstructed by small obstacles, and the spray produced by the two inclined jets is at once copious and powerful.

The following is a more detailed description of the machine, very much in the inventor's own words, Fig. 74 being a vertical section and Fig. 75 a detailed view of the axletree, showing the parts connected therewith in section:

In the drawings, *A* represents the frame of a vehicle, *B B* the wheels, and *C C*¹ the two axles constituting the axletree, which have their bearings *c* fastened below the frame *A*. Between the bearings *c* the axles *C C*¹ are provided with shoulders *c*¹, whereby they are prevented from parting with each other longitudinally, while a socket, *o*,

at the inner end of the axle C^1 incloses the inner end of the axle C , and thereby prevents both axles from moving out of line. The two said axles may be coupled by means of a pin, c^2 , inserted into the socket c^3 and axle C , but usually it is omitted, and the axles

FIG. 72.—THE DAUGHTERY ATOMIZER.



C C^1 are allowed to revolve independently of each other. The hubs b of the wheels B B are provided with set-screws b^1 or coupling-pins b^2 , or with both, in order to fasten them to the axles C C^1 . The use of the set-screw b^1 and pin b^2 may be dispensed with to allow the wheels to run loosely on the axle, in which case a collar, C^2 , is placed on either side of the hub b , with a set-screw, c^4 , to keep the wheel from sliding longitudinally on its axle. The described application of the wheels B B to their axles serves to enable the operator to set

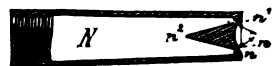


FIG. 73.

the barrel G through the pipe K into the air-vessel J, from which it exerts its pressure upon the surface of the water. When a sufficient pressure is obtained the stop-cock O is opened, whereby the water is forced into the pipes L, M, and m, and thence through the nozzles N. If the pressure of air within the barrel G and the air-vessel J becomes too great, the surplus is let off by the safety-valve j into the air. At the same time the pulley e moves the shaft f and the agitator-arms f', whereby the agitation of the liquid by the air forced through the openings i' is increased in force.

The inventor of this machine, who is a practical machinist, has probably given more time to it than has been given to any of those described in this bulletin, his object being at once to accomplish the desired end of throwing a fine spray from below, to pass over tall cotton without injuring it and to save labor. The great objection to the machine is its complication, expensiveness, and weight. It differs from the Johnson machine in that the wheels are so widely separated that they include two rows of cotton, and the whole machine is so elevated that the tongue is on a level with the backs of the animals which draw it, and the cross-tree is connected to a peculiar saddle, so that the whole weight of the machine falls upon the back. In practice this is found to be very galling to the animals, and various modifications have already suggested themselves to the inventor. There is little hope of this machine coming into use until Mr. Daughtrey succeeds in materially reducing its weight and cost, notwithstanding the excellence of many of its features.

Machines for applying Vapors.

Several years before mineral poisons came into use against the Cotton Worm two machines were invented and patented for the wholesale destruction of the insect. They are of interest here as illustrating the first attempts made to destroy the pest by machinery. One of them is more particularly worthy of mention, as it aims to apply one of the deadliest materials against insect life known, viz., oil, and this in the shape of vapor. The other is intended to apply sulphur vapor. Whether these machines were ever in use or whether they ever did any effective work is extremely doubtful, but it is certain that they are to-day superseded by the atomizers already described. The accompanying descriptions of them have, therefore, historical rather than a practical value.

THE STEINMANN VAPORIZER.—This was invented by Mr. Charles Steinmann, of Napoleonville, La. (patent No. 74165, February 4, 1868). Its character may be thus briefly given: Steam is raised by a transportable steam-boiler and issues from a series of jet-pipes or nipples. At the same time some cheap oil, as kerosene, lard, or cotton-seed oil, is made to drip from a reservoir over the orifices from which the steam escapes. The oil is thus vaporized and envelops the rows of plants between which the machine is to be drawn. The inventor claims that the vapor kills the worms without injuring the plant, and that one application will protect the field for the rest of the season, and that his invention "upon its general use will finally exterminate every tribe of insect,"

&c. It is hardly necessary to say that the two latter claims are utopian and extravagant.

The following is a description of this machine in the inventor's own words; the Fig. 76 being a side elevation, and Fig. 77 a rear end view of the machine:

A represents the receiver or reservoir to contain the oil, and B a funnel for supplying the boiler with water, and which connects directly with a heater, E, that is placed

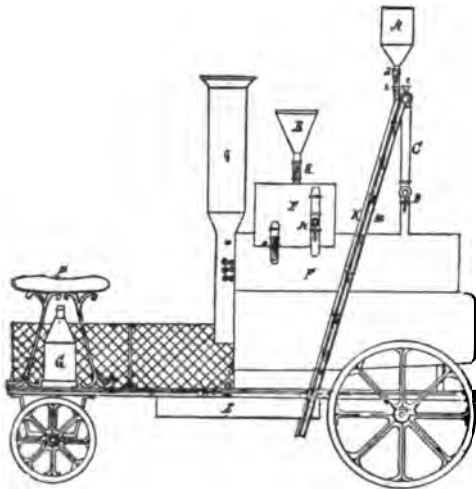


FIG. 76.—THE STEINMANN VAPORIZER: side elevation.

on top of the boiler, instead of with the boiler proper, in which heater a supply of water is always kept, to be heated by the radiation of heat from that part of the boiler or shell of the boiler on which it rests. The interior of the heater is connected with the interior of the boiler F by two pipes, H and O, which are each provided with a stop-cock. By this mode of connection, the water in the heater can be retained or driven into the boiler at pleasure, it being only necessary to keep the cocks closed to retain it, or to open them to force the water into the boiler. The latter result is accomplished by the pressure of the steam through pipe H, the water going into the boiler through

pipe O. Whenever the water is thrown out of the heater into the boiler, the former should be refilled through the funnel B, the stop-cock, in the short pipe R to which it is attached, being opened to allow the water to enter. On top of the boiler, at some point between its rear end and the heater E, a perpendicular pipe, C, is inserted into it, which pipe should be long enough to carry its upper end to a height somewhat above the tallest cotton-plants. The pipe C is provided with a stop-cock, D, and connects at its upper extremity with a cross-pipe, M, of the form as shown at Fig. 77, and to approach very near the ground at both its ends. In that portion of the pipe M that is horizontal are two stop-cocks, one upon either side of the point of connection with pipe C, which serve the purpose of stopping the issue of steam either entirely, or upon one side only of the machine. At a point near and below the flexures or elbows of the pipe M at which it turns towards the ground, on both sides of the machine, and from this point down to the two extremities of the said pipe, at short intervals, are inserted small short pipes *a*, which, diminishing in size to their extremities, where they come very nearly to a point, serve as vents or jets for the escaping steam when the machine is in operation. Placed alongside the pipe M, in front of it, and in contact with it everywhere, excepting only for a little space near its top part, where it bends forward, as shown at Fig. 76, is another pipe, K, exactly corresponding with pipe M in size and shape, and provided with the same number of precisely similar jet-pipes, *a*, that are so placed as to be exactly over the corresponding jets in pipe M, that is to say, at their extremities, and in the closest possible contact therewith. The object of this is to insure the dripping of the oil over the orifices from which the steam escapes. Over the center of the upper

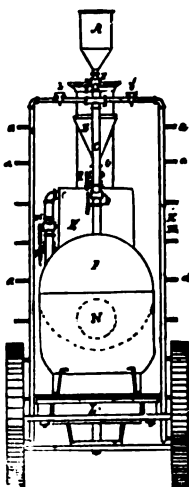


FIG. 77.—THE STEINMANN VAPORIZER: rear view.

of the oil over the orifices from which the steam escapes. Over the center of the upper

and horizontal section of pipe K, and connecting therewith by a short pipe, *d*, is placed the reservoir A for oil. Stop-cocks in the pipe K, near to and upon each side of the pipe *d*, prevent a flow of oil down either end of said pipe K, or permit it to flow into both or only one end, as occasion may require, at the pleasure of the operator. A platform in front of the boiler or furnace is provided on which a supply of fuel may be carried, a light railing or lattice-guard on the sides of the platform protecting it. A driver's seat, P, is placed on this platform under which a vessel of oil may be carried, as well as other things needed in the operation of the machine. This invention may be of any dimensions, to be drawn by one or more horses.

THE PERL VAPOR-GENERATOR.—This was invented by Dr. M. Perl, of Houston, Tex. (patent No. 91365, June 15, 1869), for the purpose of destroying the worms by means of sulphur vapor, and consists, in the main, of a gas-generator, which is placed on a cart, intended to be drawn between two rows of cotton, and provided with a fire-box and a pair of bellows, which are worked by means of a pulley.

The accompanying diagrams (Fig. 78) represent this machine, the upper figure being a vertical section and the lower a side elevation.

Upon the wagon A is placed the gas-generator B, consisting of a fire-box, *c*, separated from the lower part of the generator by a concavo-convex bottom *c'*.

To the upper chamber D of the generator is attached one end of the blower or bellows E. This bellows is provided with a shaft, *d*, upon which are secured metal wings, *d'*.

On one end of the shaft *d* is attached the cog-wheel *e*, gearing into the cog-wheel *e'*, secured to the wagon-wheel G. The other end of the shaft is provided with a crank, *f*, which is attached to upper end of pitman *i*, the lower end of this pitman being attached to the pedal *h*, secured to pendants *h'* *h''*, attached to the under side of the axle-tree H. *G''* is a hose, with a perforated nozzle, *m*, and stop-cock, *n*, which is attached to the top of the gas-generator. M is the chimney.

The machine can be operated, when in motion or stationary, in the following manner:

A fire is made in the fire-box *c*, and a certain quantity of sulphur is placed in the gas-generator B, in order to form sulphureous gas. The blower E is set in operation, when in motion, by the cog-wheels *e* *e'*, and when stationary, by detaching the cog-wheel *e'*, and attaching it to the crank *f*.

The action of the blower or bellows will not only furnish sufficient air in forming sulphureous gas, but it will also force the gas through the hose to any desired point.

Aside of the circumstance that only two rows of cotton are supplied at once with vapor, it is very doubtful whether the worms are killed by sulphur vapor in the open air, judging from its effects on other insects when not confined.

Finally, in this connection it is well to state that Mr. Charles T. Hurd, of Victoria, Tex., whose machine for dusting has already been described

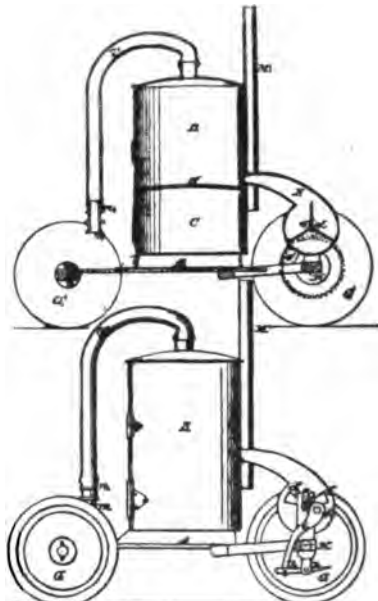


FIG. 78.—THE PERL VAPOR-GENERATOR.

(p. 76), suggests that with some slight changes it can be converted into a vaporizer, so as to throw a jet of poisonous vapor on the plants.

DESTRUCTION OF THE MOTH.

Easy as it may seem to prevent the mischief done by the worms by trapping or otherwise killing the parent moths, and notwithstanding the fact that one method of attracting them has been known and used for very many years, and that another method of doing so has been more recently discovered, yet the results that have followed the attempts to destroy or exterminate the moths by these methods are not, as a rule, encouraging. The unsatisfactory results may be attributed to, *first*, lack of concerted action; and, *second*, delayed attempts to kill when the moths had already become too numerous and the worms had done considerable damage.

It has already been remarked, with regard to the first point, that concerted action over the whole cotton-growing country cannot be expected; but if the planters in those more or less limited districts that are known as the distributing centers of the insect, or even in those particular spots where the worms appear and reappear year after year, would make earnest effort, at the right time, to trap and kill the moths, there is little doubt but that the excessive increase of the insect would be either retarded or prevented. If this pest is suffered to increase until the third or fourth generation, any attempt to lessen the number of worms by killing the moths will necessarily prove futile. To make this method of preventing injury of any avail, action must be taken *early* in the season.

Lamps for attracting the Moth.

That the moth is attracted by light is an old and well-known fact, and in the days of slavery the only remedy generally used by planters, besides the hand-picking of the worms, was to light large fires in, or have burning torches carried through, the fields at night. It is impossible to say at the present time whether or not these efforts were successful, but it remains a certainty that in "worm years" the progress of the ravages has never been prevented by such means. It is almost needless to remark that in those days, as in the present, such means were generally resorted to when the moths had become quite numerous, and when, therefore, no success could be expected.

Special fires intended for this purpose were generally made of dry wood placed upon earth elevated on platforms. While for the reasons here given I have little faith in the utility of such means at any other season than early spring, yet the practice of cleaning the fields of all rubbish and old stalks by making large bonfires in winter—a practice that prevailed before the war, but which has been largely abandoned since—is greatly to be commended on general grounds.

It has been found troublesome, and, in some parts of the country even

expensive, to keep up large fires during the whole or greater part of the night; and during the last decade a great many lamps have been invented to take the place of fires. A lamp is more effective in attracting the moths than is a large open fire; for the heat and smoke of the latter scare away great numbers. Where lamps are employed there must be connected with them devices to kill the moths that are attracted by the light, and such killing is best accomplished by placing the lamps in pans filled with various substances of a sticky or destructive nature.

During the earlier part of last summer extensive experiments were made by Mr. Schwarz to test the efficacy of lamps. Though it was already too late in the season to check the increase of the insect, some of the results are not without interest. The number of moths nightly killed by a single lamp varied very much according to its location, but averaged not more than six specimens in the latter part of June, the number increasing rapidly during the next month. It was also found that these lamps attract and kill an immense number of other insects. Among these are many injurious insects, as *Heliothis armigera* (the parent of the Boll Worm), which, by the way, appears to be more readily attracted than the Cotton Moth, and several species of May-beetles (*Lachnosterna*) and others; but also, unfortunately, large numbers of the natural enemies of the Cotton Worm, as the nocturnal Tiger-beetles, Ground-beetles, and some of the *Heteroptera* already mentioned. It becomes questionable, therefore, whether the lamps are not more productive of harm than good, especially at times when the moths are numerous. However, if, as is doubtless the case, the hibernating moths fly about early in the spring, then this will be the best time to use lamps in places where the moths have been seen flying, as in the vicinity of gin-houses, &c. In the month of March and in the earlier part of April they should be placed at such spots in the fields where the first worms had been observed in previous years.

Experiments made under my direction have proved that during moonlight nights fires or lamps have but little attraction for the moths, and, further, that better results are obtained before than after midnight.

The only instance with which I am familiar where lamps (those made by Colonel Lewis and hereafter described) have been used on a sufficiently large scale to fully test their efficacy, is that around Hearne, Tex., in 1878. Over 1,000 lamps were used in that vicinity during a period of several weeks, and while it was true that cotton was not injured that year, the same was equally true throughout that whole section of the country; so that it was impossible to draw any satisfactory conclusions. Still, where they were used pretty extensively the present year they did not prevent final injury to the cotton, and where but a few are used in some particular fields, it is undoubtedly true, and in accordance with general experience, that more harm than good ensues to the individual using them—the moths being allured from other fields and frequently laying their eggs before perishing. The worms are, consequently, often more numerous at such centers than elsewhere.

The following enumeration of lamps for attracting and killing the moth is by no means a complete one. Some of the inventions are no longer used, and descriptions or samples of them unattainable; others are mere copies of such as are here described, and are therefore omitted; while still others are too complicated and expensive to warrant mention. A few words have still to be said concerning the mixture to be used, in connection with the lamps, for killing the moth. Almost any sticky substance, such as paint, tar, molasses, soap-suds, &c., will answer the purpose; but the cheapest and most effective means is to half fill the pan with water, and then pour in about a table-spoonful of kerosene. The mixture can be strained off in the morning and used again.

The lamps may be divided into two classes—those which are to be kept stationary, and those which are to be drawn or carried through the fields.

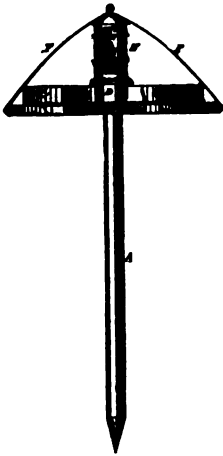


FIG. 79.—THE GARRETT LAMP.

kept in place by being secured to the edges of the plank (B) by two or more cords (F). Into the pan (C) some coal-tar or molasses, or other suitable material, is poured so as to a little more than cover the bottom thereof.

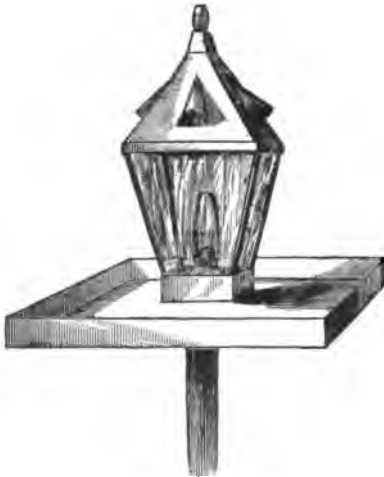


FIG. 80.—THE BINKLEY LAMP.

THE BINKLEY LAMP.—Mr. J. N. Binkley, of Columbus, Tex., uses a lamp which I herewith illustrate (Fig. 80). It is essentially the same as the foregoing, and consists, like Garrett's lamp, of a tin plate which may be rectangular or round, and which is placed on a board, nailed to the upper end of a stake or pole. A lantern of the form shown in the figure is soldered to the centre of the plate, the cover of which lantern has openings to aid ventilation, and may, when necessary, be removed. A common kerosene lamp, with or without chimney,

is placed in the lantern, and the pan is half-filled with water and a little kerosene on top, or with soap-suds, or molasses, &c.

A similar but still simpler lamp, first made by Col. Charles Lewis, of Hearne, Tex., has for some time been in use in the fields in the Brazos River bottom. It consists of the usual shallow tin plate placed upon a board that is nailed to the upper end of a stake or post. In the middle of this pan is placed a common kerosene lantern, large enough to burn the whole night, or at least the larger part thereof. In 1878 the planters near Hearne, Tex., were nightly burning over 1,000 of these lamps during a period of several weeks. The cost of this lamp, with the tin pan, is between 30 and 40 cents, and the cost of burning it one night about one cent. One lamp is generally used for every five acres where the land is level, but at shorter intervals where it is rolling.

THE MCQUEEN LAMP.—This again does not materially differ from the others so far mentioned. Patented by Mr. B. F. McQueen, of Manack, Ala. (No. 166124, July 27, 1875), it consists of an ordinary lantern which is secured to the center of a shallow basin, beneath which is fastened a tube intended to fit on a post or stake. At the top of the lantern is a horizontal screen of tin, forming a reflector and serving also to precipitate the insects in the pan below.

THE RIGEL LAMP.—Invented and patented by Mr. Mark Rigel, of Ala. (patent dated January 28, 1873), this lamp differs only in being made so as to hang by a ring, and in the lantern having, in addition to a horizontal reflector, several vertical ones.

There is another class of lamps of a still simpler nature, consisting of a torch-light, large enough to prevent its being extinguished by the wind, and placed in the middle of a tin pan. While cheaper than those with a steady light they are decidedly less effective, and, moreover, they consume more oil. The simplest lamp of this class is a stout bottle filled with kerosene and mounted with a wick.

THE WALKER LAMP.—This has been constructed by Mr. John E. Walker, of Winchester, Tex., and is represented herewith (Fig. 81). It consists of the usual tin pan placed on a post, and of a short, funnel-shaped pipe soldered to its center. A second hollow tube of the same shape, inverted, is attached to the bottom of the oil-reservoir so as to fit firmly over the first. The reservoir has at the top a raised mouth, with a worm, through which the oil is poured and on to which the wick-tube is screwed as in the figure, the lower part of the tube which enters the reservoir being perforated. The shoulder above the screw is designed to prevent the falling of cinders or fire into the kerosene.

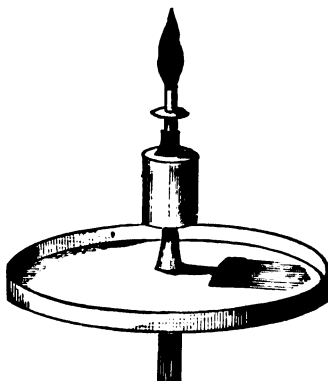


Fig. 81.—THE WALKER LAMP.

One of the simplest lamps is that which I herewith illustrate (Fig. 82). It has been extensively used and is a mere modification and simplification of the Walker lamp. The reservoir is here soldered to the center of the pan, and the wick-tube to the top of the oil-reservoir. The oil is poured in through an opening near the edge of the top of the reservoir.

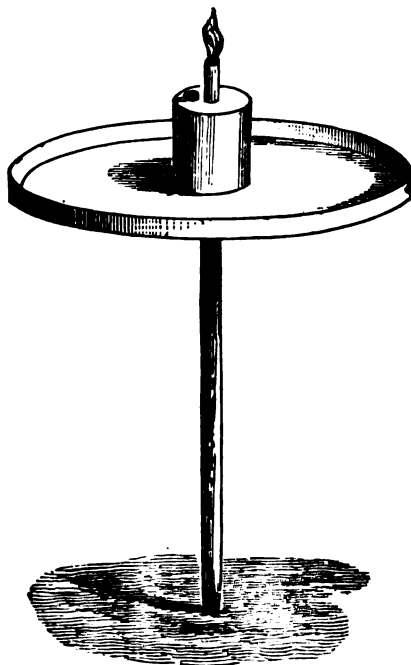


Fig. 82.—SIMPLE FORM OF LAMP.

THE PUGH LAMP.—Another somewhat more complicated contrivance of this class is that invented by Mr. Edward D. Pugh, of Fort Plain, Iowa (patent No. 130390, August 13, 1872). Fig. 83 shows that it consists of the usual shallow pan A, wherein is placed a rectangular case, B, made of glass and sheet-iron, with short feet attached to its bottom and with a cover, c. The bottom is perforated for ventilation, and a lamp, D, is placed within the case. So far there is nothing particular about

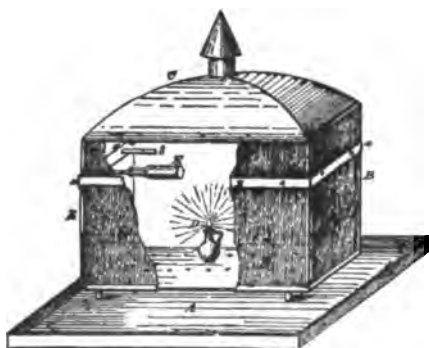


Fig. 83.—THE PUGH LAMP.

this lamp, but it has, in addition, an arrangement to increase its attractiveness to the moths. Around the case is a frame, *a a*, with tubes, *b b*, attached to the inside and aperture communicating with the outside. E represents a common, long-necked bottle placed on one of the tubes *b*,

on the inside of the case. The number of the frames and of the tubes may vary, but on each of them a bottle is placed containing honey and wax, or other suitable bait that is attractive to moths, which are consequently not only attracted by the light, but by the smell of the baits, and are either killed by falling in the pan or by passing through the apertures into the bottles, from which they cannot escape.

LAMPS IN MOTION.—As a result of the observation that the moths that are flying in the field are not so readily attracted by a stationary light as by one in motion, the two following machines have been invented with a view of being drawn or dragged through the field: The first of these is the **LE BLANC COTTON-MOTH DESTROYER**, invented by Mr. Auguste Le Blanc, of Louisiana, La. (patent No. 101028, March 22, 1870), and represented at Fig. 84. The apparatus is mounted on wheels (A) and consists of a platform (B), to which are secured a number of extensible posts (c) supporting a roof (D), from which is suspended by a chain or rope the devices to obtain the light. This device consists of the reservoir (E), which communicates through pipes (a and b) with a series of radial burners (F), which are arranged so as to form a circle of about eight feet in circumference, though the dimensions may be increased or de-

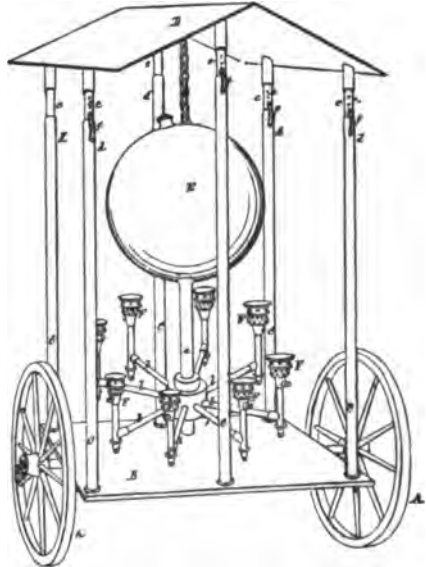


FIG. 84.—LE BLANC'S COTTON-MOTH DESTROYER.

creased. The posts (c) are rendered extensible by being formed in two parts (c d), the one fitting and sliding in the other. A series of holes (e) are made, one in the part (c), while a spring stop or pin (f) is fixed to the other (d). By this means the burners may be raised or lowered at pleasure. The roof does not serve alone to shield the burners from rain, but, if painted with a white paint or with any other sticky substance, also helps to attract and destroy the moths. In order to use this machine effectually, Mr. Le Blanc suggests that the cotton should be planted so as to leave at intervals, say, of two acres, a space wide enough between the rows to permit the machine to pass through.

The second machine to be mentioned in this connection is the **FORDTRAN COTTON-MOTH DESTROYER**, invented by Mr. E. H. Fordtran, of Flatonia, Tex. (patent No. 196211, October 16, 1877). It consists of two S-shaped runners very much like those of a common sleigh, and which are made of bent gas-pipes. They are connected with each other at their upper end by a cross-beam, to which is attached a tongue for draw-

ing purposes. Another gas-pipe between these runners is so fastened to them that it can be lowered or raised, according to the height of the plants, by sliding along the runners; and on this pipe are several movable rings which can be firmly secured to the pipe by means of a screw. These rings support each a round shallow tin pan, which, by means of the movable rings, may always be held in a horizontal position. In the middle of each of these pans (the number of which may vary) is secured a common kerosene-lantern. The apparatus, which is large enough to reach over three rows of cotton, is drawn over the field at night time. It is on runners and not on wheels, because the former do not injure the cotton.

These movable lamps are doubtless very effective, and if used extensively and at the right time would be of good service. Aside from the unsatisfactory results of lamps generally, these have an additional disadvantage in that they must be worked at night.

Poisoned Sweets and Fluids as Means of destroying the Moths.

It has long been known that the Cotton Moth, like most of the other species of its family, has a great fondness for sweets. Southern writers upon the insect repeatedly mention the fact that the moth is numerously attracted by barrels or other vessels containing molasses, by sugar-vats, &c.; while, as we have already seen (p. 15), it is very fond of most ripe fruits. The second peach-crop very often suffers materially from the attacks of these moths, as, by means of the spinous tip of their tongue, they literally work through the skin, suck out the juices, and excavate large holes. Figs and melons are often injured in the same way; indeed, it is almost impossible to raise some of the finer varieties of figs if these moths are abundant.

There was some hope of beneficial results being obtained by using baits that would prove at the same time attractive and destructive to the moths, since, if we kill the parents, we prevent the injury of their progeny. Taking advantage of the fondness of the moths for sweet substances, many planters have been in the habit of breaking open ripe watermelons, sprinkling them with Paris green or arsenic, and depositing them in cotton fields. Very good results have followed, so far as the destruction of the moths is concerned; and it is a little surprising, viewed at from the preconceived notions of entomologists, that comparatively coarse substances like these minerals should be sucked up through the proboscis.

A number of experiments, with a view of testing the most attractive as well as the most deadly substances, have been made in various parts of the cotton belt during the past two years under my direction. Ripe peaches dusted with arsenic or drenched with a solution of arsenic, dried peaches moistened with water and poisoned in the same way, were placed in boxes on the ground in the fields. On examining the boxes the next morning, several dead moths were found in those containing

the fresh peaches, but none in those with the dried ones. Experiments with a mixture of molasses and rum, or vinegar, or beer, poisoned with a small quantity of arsenic, Paris green, London purple, or cyanide of potassium, and smeared onto the trunks of trees, or onto fence poles near cotton fields, or again onto the leaves of the plants, also proved that a number of moths may be killed in this way, though it is difficult, if not impossible, to get at the exact number, since many fly away before dying: The mixture of molasses and beer seems to have the greatest attractiveness, and the virtue of all these mixtures for this purpose may be enhanced by the addition of the essence or flavoring extracts of certain fruits, as peaches and apples. None of these mixtures are as attractive, however, as the fruits themselves, or even as watermelons.

The liquids may be employed not only by smearing in the manner set forth, but also in shallow tin pans or vessels placed in the fields upon pedestals, as in the case of the lamps already described. Where such pans or other vessels are used there should be a wooden lattice-work made to float on the liquid, so that the moths may reach it without drowning, and thus be able to get away to perish elsewhere and make room for others. These liquids are frequently used in wide-mouthed bottles distributed over the fields. One general rule, already laid down in treating of the use of lamps, should be observed in the employment of these liquids and poisons. It is that they be placed in the field only about sunset, and not allowed to remain during the day; otherwise, more beneficial than injurious insects are actually allured. The smearing has the advantage over the use in pans and bottles, in that fewer beneficial insects are destroyed.

I cannot say that these experiments have led me to be in any way sanguine of substantial benefit flowing from this mode of killing the moths in the autumn, which is the season when they are most easily so destroyed; for they do not seem to care much for such baits except when they cannot get their more natural food, in the shape of saccharine exudations. The fact that early or summer ripening peaches are not injured—a fact that is well attested by many correspondents—also indicates that the moths do not care so much for fruits even, so long as they can obtain nourishment in the cotton fields and so long as they are not congregating in numbers.

Experiments made in the summer season with these artificial baits indicate that a much smaller percentage of moths is allured thereto, and while there can be no question of our ability to kill a certain number in this manner, it would prove a most expensive remedy if used on a sufficiently large scale to materially reduce their numbers. In fact, I have become convinced that there is very little use in attempting to destroy the parent moth in the latter part of the season. In discussing the question of hibernation, it has been made pretty clear that the great bulk of these are naturally destined to perish in any event, so that the labor is largely thrown away.

Until, therefore, we discover some baits that shall have a greater attraction for the moths than the natural sweets they feed upon, there is little to expect from this mode of warfare. There is a season, however, when the use of these baits is strongly to be recommended, and, oddly enough, it is the season when nobody thinks of using them. It is in this as it is with the lamps; the greatest good will result from attracting and destroying the first moths in spring after they issue from their winter quarters. Every female killed at that season is equivalent to the destruction of several hundred worms later in the season, whereas not one in a thousand; and perhaps not one in a hundred thousand, of the moths killed in autumn would, in the natural course of events, have survived to beget progeny. Concerted action is just as necessary here as in the use of lamps.

The recommendation to use white rags in the field has frequently been made in the Southern papers, on the supposition that the female moth is attracted to such rags and will lay her eggs thereon. I know not how this idea originated, but so far as I am able to learn it is one of the many fallacies that have prevailed regarding the habits of the insect.

Finally, in this connection, I would mention a theory or proposed remedy by Dr. J. L. Lupton, of Frederick County, Virginia. Noticing that the Bee-moth was more attracted to a fluid sweetened and flavored from the hive than to any other kind, he conceived the idea that the Cotton moth would also be most attracted by sweetened water which was flavored with the bruised leaves of the cotton plant. Prof. N. T. Lupton, of Vanderbilt University, Nashville, made an experiment in 1872 which seemed to indicate that the liquid thus prepared with cotton leaves had the greater attractiveness for the moth as compared with ordinary molasses and water; but it is doubtful whether it would compare as favorably with some of the other mixtures already alluded to.

APPENDIX.

[As a sequence to the Bulletin proper, and as illustrating the conflicting views and theories held by the more intelligent correspondents, I add a few of the reports received in response to the circular printed in the Introduction. The replies are numbered to correspond with the questions, and it is hardly necessary to inform the reader who has perused the Bulletin proper that the views and theories of the different writers are not necessarily indorsed, because they are printed just as they were received, and without comment.]

SAINT FRANCISVILLE, WEST FELICIANA PARISH, LOUISIANA,

October 2, 1879.

A circular from you requesting answers to certain questions relative to the Cotton Worm was received some months since, and my reply has been deferred to this date in order to enable me to observe the worm and its depredations throughout the entire season. Last year a similar circular was received from the office of the Agricultural Department, to which I replied fully and specially to all the questions as far as my information extended.

1. Cotton has been grown here since this century began—eighty years—and perhaps longer. I am a native, fifty-eight years old, and my family and relatives came here from North Carolina in Spanish times and soon afterwards, *i. e.*, from 1800 to 1810. They always raised cotton from their first settlement here.

2. I have no records or histories to refer to in order to answer this question fully and accurately. From old settlers I have heard that the Army Worm came here before my recollection—this is, before 1827 or 1828—and destroyed the crops. I think this was between 1820 and 1824. I have heard old settlers who came here from South Carolina say that the Cotton Worm came there before 1815, and ravaged the crops. From my recollection, the worms never appeared here in any great numbers after 1828 until 1840 or 1841. I was raised on a plantation, where I now live, my father and all of my family on my father's and mother's side being large cotton planters, and my recollection dates back to 1828 about all matters of any great moment.

In the above year, 1840 or 1841, I returned home on a visit from school late in the fall, say October, and found the cotton fields white with the open cotton and filled also with Cotton Worms. In a few days they ate all the leaves from the stalks of cotton, and then began to crawl off, moving like a great army, and filling the ruts and washes in the roads and fields with millions of worms, which being unable to crawl out died there in masses. As the worms appeared that year quite late in the season, no damage was done to the cotton crop, except to make the open cotton dirty and trashy from the excrements and cut leaves dropped by the worms on the cotton.

In 1846 the worms appeared again, and that year the crops were greatly injured, the worms eating the cotton up so early in the season that not more than 50 to 70 per cent. of a full crop was made by planters in this section. The worms never came again in sufficient numbers to attract any general notice until after the war began. We heard of their appearance soon after the Federal occupation of New Orleans and the lower part of the State, from the great desire to get cotton to supply the markets and factories abroad and at the North and the many attempts made in that region to raise cotton for that purpose. Inside of the Confederate lines, in this section, very

little cotton was raised during the war, the people turning their attention almost exclusively to raising food crops. Worms appeared, however, in the small fields of cotton raised here for several years before the war ended. Beginning with 1866, they have been in this section every year since, sometimes many and again very few; but no year has passed with an *entire* absence of the worm since 1866.

3. I do not think the coldness or mildness of the winters affects the worms here—our winters are never very cold—as our latitude is too far South to permit it. We have had very cold weather, for this section, many times since 1866, and the worms have appeared every year, more or less.

4. They are always worse in wet summers; never very bad in very hot, dry summers. They are generally noticed first in July, and if its after progress is attended by repeated rains during July, August, and September, the crops are very apt to be much injured, if not completely demolished. But if it remains hot and dry during the above-named months, the worms never do much damage.

5. Of my own knowledge, they are to be seen here first in June or July, but some of my friends and neighbors have reported seeing them occasionally in May, in few numbers.

6. They are almost always found first on the same places and same plantations, scattered over the country, without any apparent regard to character of soil or surrounding circumstances. This fact has been generally noticed and spoken of, but no solution has been made of it that is satisfactory and reasonable. Like most other questions among men, outside of mathematics, discussion never satisfies all parties nor settles the question.

7. I have no experience at all of the winter habits of the insect, but I am satisfied it remains here during the winter, in some form, and does not come here regularly or at intervals from any distance. My reasons for thinking so are too numerous to attempt to write them to you, unless I thought I could prove the fact to a demonstration, and thus settle the matter beyond all future question or dispute.

8. Birds of many kinds prey upon the worms, and many insects prey on both the worm at all ages and stages of its growth and also feed on or destroy the eggs. No quadrupeds disturb either eggs or worms, to my knowledge. Ants of various sorts prey on them—both eggs and small worms. I have heard many insects spoken of, by persons who had given the matter close attention, as being enemies to the Cotton Worms, and preying on or destroying the eggs, young worms, and also those fully grown. I cannot speak on these points from personal knowledge, not being a scientist nor professional man, and having no turn of thought in that direction. I am satisfied that many animals and insects prey on and destroy the Cotton Worm's eggs, young, and grown worms, or they would eat up the cotton every year they appear here. They increase by nature so very rapidly after their first appearance that, unless they met many and destructive enemies besides man, they would always increase in numbers so great as to destroy the crop annually. In wet years these various enemies are not present themselves in sufficient numbers to make any impression on the Cotton Worm, but in dry seasons they are numerous enough to nearly annihilate the Cotton Worm, and thus prevent any great damage to the cotton crop.

9. I have no experience about destroying the Cotton Moth. Many might, no doubt, be destroyed by lamps, fires, &c., but the whole planting population would have to engage in it systematically and persistently, or it would amount to nothing. The destruction of any number of moths by a few planters or neighborhoods would do no good. I have never heard of sugar, molasses, or anything of the sort being tried to lure the moths. I think all such things humbugs, and on a par with the Yaukee plan tried in Lower Louisiana during the war, *i. e.*, to spread tar around the cotton-fields to prevent the Cotton Worms from entering them.

10. I have no experience to enable me to reply to this question.

11. I cannot afford any information on this question.

12. I have never seen jute nor any other plant being tried in this section for any such purpose. Have heard stories told of such things being tried elsewhere.

13. Paris green, Texas Worm Destroyer, and such poisonous medicine are the only things which have ever been used here to destroy the worms. I have seen Paris green tried many times, and heard of its trial for years. There is no doubt that it will destroy the Cotton Worm and preserve the cotton plants, when the preparation is genuine and not a cheat and it is used properly and thoroughly. Like everything else done in this world, it must be done properly, thoroughly, and persistently to succeed. I have no personal knowledge of the Texas Worm Destroyer, but it is very highly recommended, indeed.

14. I have never known any injury to happen to man, beast, or plant here from using Paris green. All know that it is a violent poison, and use it with caution. No doubt, man, animals, and plants can be injured by it, and perhaps all have been injured in some places by its incautious use.

15. Paris green used in liquid form, from large tin watering-pots made specially for the purpose, has been most successful here; it is the preparation generally used.

16. I cannot state the cost of using Paris green per acre, but its cost is not great, and does not enter into any man's calculation when he sets about to kill the Army Worm. I have seen a field of cotton saved by two applications of it, which were made at intervals of a month apart. This field yielded one bale per acre, whereas without the destruction of the worms it would not have made half a bale per acre. These worm-poisons are now made and sold in great quantities by responsible parties, and, like all other articles of general commerce, are abundant and cheap. There is no question but that the cotton crop can be saved in part, if not in whole, from any future destruction by the Cotton Worms, in all sections where the planters are energetic, intelligent, and harmonious in action by the use of poisons—Paris green, Texas Worm Killer, arsenic in some form, or some other poison. I cannot now say that any plan can be proposed to destroy the worm or moth before its appearance in the cotton fields. Fires, lamps, &c., would kill immense numbers of moths, but would only retain the worms, and not destroy them.

I hope what I have written above may prove acceptable to you. I have given you all the information I could which I could vouch for personally. Any future communication from you or your office will be replied to fully and candidly.

The Cotton Worms have made their annual appearance in our parish this year, but have done no general damage. Some few fields have suffered, on alluvial lands, so far as I have heard. The summer has been very hot and dry.

Very respectfully, your obedient servant,

DOUGLAS M. HAMILTON.

C. V. RILEY, *Chief U. S. E. C.*

EVERGREEN, ALA., *August 24, 1879.*

I beg leave respectfully to submit the following answers to your circular (No. 7) concerning the Cotton Worm:

1. About the year 1817.

2. In 1825, or about eight years.

3. It is most generally dreaded after a mild winter, but experience teaches that this fear is ill founded. It is probable that a greater number of the chrysalids survive a mild winter than a severe one, but the present season proves that they cannot all be destroyed by cold, for having passed through the severest winter since their advent, the worms are at this time (August 24) destroying the cotton in some localities, and bid fair to make a clean sweep within the next two or three weeks.

4. Wet springs and summers are decidedly more favorable to their production than dry ones.

5. On or about the 25th of May, 1873.

6. In moist, rich soils, where the weed is most luxuriant.

7. I know but little from actual observation. I have seen the chrysalids in the ground exposed by plowing, sometimes under turfs or logs, or anything that affords protection from cold and wet.

8. None. Every variety of birds feed upon them, but there are not enough birds in a State to devour all the worms on a single plantation. The English sparrow is the only bird that could be introduced which would be available, and it is not considered practicable to try him, for the number required to do the work would require a vast amount of food at all times, and of itself become a greater pest to the farmer than the worm.

9. All efforts in this direction have been fruitless. The writer is of the opinion that as soon as the moth emerges from the chrysalis it proceeds at once to deposit its eggs (of which it contains a vast number), and are not attracted by anything to be eaten until they have performed that function. They are attracted by any saccharine substance, like sugar and water or molasses and water, but, for the reasons stated above, they are considered of little value. Fires or lights will also attract them, and, if not too expensive, might be more available than poisons. Owing to the uncertainty of the time of their advent, and of the very short time required for the laying of their eggs, the plan of destroying by fires can hardly be made available, however.

10. It is immaterial whether the poison is contained in vessels or spread upon boards, trees, &c.; they are as likely to find it at one place as another. The writer has seen myriads of them destroyed by dropping into evaporators used in making sirup. This, however, is never observed until late in the fall, after the cotton is destroyed and the color of the moth is changed. The last crop of worms are black, or nearly so, and the moth springing from them is of a darker hue than the first seen, and are non-productive. Those coming from the green worm are brown, and supply all the eggs.

11. There are none known to the writer.

12. I have no experience with jute, but have seen cotton grown among corn escape the ravages of the worm when all other was destroyed. The writer does not favor the plan, however, practiced by many cotton planters, of crossing cotton with corn at from 12 to 20 feet, inasmuch as the effect of retarding the progress of the worms is not successfully attained, and the corn thus made will little more than pay for the cotton lost, besides impeding the cultivation of the cotton in case the corn is blown down or bent by wind (as happens as often as not). In the opinion of the writer, the better plan is to plant *cotton in corn*; i. e., after securing a stand of corn early in the spring, plant a hill of cotton between each two hills of corn, so what corn is made may be considered clear gain. If the corn is not bent, the cotton may be worked after the corn is "laid by," and if it is bent, so as to prevent the cultivation of the cotton, nothing is lost by having the cotton there. Of course this plan can only be made profitable on good land, where the cotton will continue to grow after the fodder is pulled. The writer saw last year, however, on poor land, more than 200 pounds of cotton per acre gathered from land where 15 bushels of corn were grown, and this with one additional working. Moreover, cotton grown alone immediately by the side of this corn and cotton was entirely destroyed by worms, while that grown with the corn was untouched.

13. Nothing. From experience in the use of a tea or decoction of the China berry on cabbage, to drive away worms, bugs, &c., the writer is induced to believe that the same might be used with success on cotton. It is well known that all insects or vermin are averse to the taste or proximity to this plant, and the writer has no doubt that a thorough application of it to cotton, made at the proper time, would drive off the worms. I will not undertake to say that it is practicable, for the labor of making the tea and applying it may overbalance the profit. In other respects, however, it has the advantage of being cheap and harmless.

14. I have seen the cotton plant scorched and ruined by using the poisons in too concentrated a form, but have seen no injury to persons or animals. Being a deadly poison, however, the Paris green will certainly kill animals as well as worms if taken

into the stomach. It acts as a poison also when introduced into the system through the blood, and should consequently be handled with a great deal of care.

15. Of the means yet discovered, no agent has the advantage of Paris green.

16. For the protection of cotton of average size of weed, an outlay of about \$2 or \$2.25 per acre will be incurred in this locality, including the cost of the poison, flour or gypsum for mixing, and labor of applying. In places where water can be had without too much labor the cost might be a little less; but comparatively few farmers have this natural advantage.

The writer takes occasion, in this connection, to suggest a solution of the "caterpillar question" in a very few words. Let every cotton planter in the South adopt a system of reduced acreage, high manuring, and thorough cultivation. Let him plant only such lands as will return a large yield, say one, two, or three bales per acre, and he can afford to apply Paris green and save his cotton. Of course, this can be done in most sections of the South only by high manuring; but no farmer should plant more cotton than he can make remunerative. If he can manure but one acre, let him plant but one. This system would not only save the cotton from destruction by worms, but would immeasurably improve the financial condition of the South and the whole country. The farmer, having less cotton planted, would have more land to devote to grain-crops and stock-raising, and after one or two years the market value of cotton would be so enhanced that he would receive as much money for his few bales as he now does for his many.

Very respectfully,

ROBT. A. LEE.

C. V. RILEY, *Chief U. S. E. C.*

HENDERSON, TEX., *November 27, 1878.*

In reference to our Cotton Caterpillar, it is hard to drive to an uncontested conclusion, as there are almost as many opinions as there are cotton farmers in the South.

I am a native of Louisiana, sixty-four years old, and have been growing cotton the greater portion of my life; still I know but little that is worth telling in reference to this terrible Southern pest. The first Cotton Caterpillar I ever saw was in Holmes County, Mississippi, in 1846. The second time I saw them, in numbers worthy of notice, was during our last unfortunate war, 1864. Since then they have appeared annually (more or less) in all the cotton States. *They appear to be migratory*, but many deny this, and support their views with some plausibility. But we are taught by experience that they do not appear simultaneously over the whole country, but annually appear in the extreme southern portions of Alabama, Florida, Louisiana, and Texas. We often hear of them four to six weeks before they raise, hatch, and accumulate sufficient numbers to reach the northern portions of these States. The first-comer (or parent) is a small yellowish fly, resembling somewhat our usual summer-evening candle fly. Whether from instinct or not, I cannot tell—but I will call it instinct—the first fly visitors always deposit their eggs in the center of each field. Why so in every instance, if it is not to place himself, as well as his first brood, as far away from birds and other enemies which might annoy them near to the forest trees and woods?

Again, they invariably deposit the eggs in the top—yes, in the bud—of each stalk or plant, for there the little embryo leaf is full of downy fuz, in which the eggs lie closely bedded, elevated high to the dew and warm sun, and soon hatch. Now we have the worm, so small as to be almost unobservable, but safely secured in his downy bed, which down is his food for a day or two, when he begins to feed on the yet small and tender leaf, and eats day and night until he webs up, to reappear another fly. This is our first crop; and from first observation of the fly until the second crop appears is about fifteen to twenty days. This second crop proceed as the first, depositing their eggs in the bud, and this time extend their dominions to three-fourths and

sometimes over the whole field, maturing as before, giving the third crop, which soon finishes the last leaf of the young fruit. I will add that many suppose this last crop, after devouring the crop, deposit their eggs in old hollow trees, old dry fence-rails, dry weeds, or other dry rubbish, to slumber till another year, and then reappear. This does not look reasonable as compared with the observations as above stated; besides, they would then hatch out and reappear at every place where they existed the year previous; so I rather believe they are migratory, and come from the south annually. I am of the opinion that if planters would top their cotton, say three or four inches below the bud, about the time they see the first fly, much benefit would be had. First, the natural place for depositing the eggs would be removed; second, if any eggs had been deposited about the time of topping, the topped part would become dry in a few hours and the egg would perish, or, if hatched, the little baby worm could not feed on the dry, parched leaf, and would thus perish. If, however, he had strength to make his way to a neighboring stalk, he could not feed so young on the lower tough leaves, as he can only survive on the downy part in the bud first and then on the youngest and tenderest leaves. Thus he acquires size and strength in a few days to feed on older leaves.

It is natural that they do not deposit the egg anywhere on logs, trees, or woody substances, or even on grown tough leaves, where the diminutive baby worm cannot feed, thrive, and live; so the last or third crop, if deposited on these substances, would soon become extinct. Therefore they are migratory and come from the south.

Then, as a remedy, I would suggest, first, to work and cultivate fast, get a good growth as early as possible, but, large or small, top the cotton as soon as you see the first fly; second, I would urge, as an additional remedy, to put up poles with martin-boxes on the top, and cultivate and raise our black martin bird. It is a South American bird, innocent and harmless to all vegetation. They arrive here in May, raise their young, and migrate the 1st of September. They are a fine, greedy insect-scraper, and increase rapidly. Again, they are by nature adapted to the work, because the caterpillar-fly works from about 5 o'clock p. m. till dark each day, and while all other birds retire to roost early, the black martin feeds till dark. In fact, this mode of furnishing artificial homes for birds would invite many of our native birds to occupy these homes, and particularly our bluebirds, which are also fine insect-destroyers. Thus, by largely increasing our birds which feed on these insects, we would be well fortified against the boll-worm fly, which much resembles the caterpillar-fly, both of which appear about the same time, first in small force, and increase very rapidly.

If birds could be distributed over the fields in these artificial homes, they would effectually destroy them on their first arrival, when so few in number. You are aware that in the early history of the Southern States, where the farms were small and few in number, then the forests were vocal with the song of birds. As the fields increased in size the forest decreased, and since our late war the freedmen all, young and old, used every means to procure guns for the purpose of killing game, and no bird, however small and innocent, is allowed to escape their deadly aim. Nor will I stop in condemning the negroes for this unwise practice, but the same holds true of our idle young white men, many of whom indulge in the practice as mere sport. Our forest songsters are now seldom to be seen, their songs are hushed, and the moaning noise of the wind in the tree-top is undisturbed by the note of the bird. Laws should be passed by all the States to put a stop to this unwise practice.

Yours, truly,

JNO. M. WOLKOM.

C. V. RILEY, *Chief U. S. E. C.*

HEMPSTEAD, *Waller County, Texas.*

I herewith send replies given by different farmers in this county in answer to the question asked on the first page, and you will see that there is a variety of ideas as to the manner of hibernation.

The questions in Circular No. 7 having been carefully answered, to your first circular, I do not think I can add any more information, save perhaps to reiterate my firmer belief in what I had stated, to wit:

That the worm has four changes: from chrysalis to moth; moth to egg; egg to worm; worm to chrysalis.

That the moth is short-lived, from five to seven days; is not an eater; always an egg-layer; remarkably timid; a strong light readily attracts them; they perform their mission and then die.

That the egg hatches in from about five to seven days; is deposited on the under side of cotton leaf in regular layers.

That the worms as they hatch proceed at once to do their mission, and take from seven to nine days to perfect themselves, when they begin to spin their web. In about thirty-six hours the chrysalis—the hibernator—is ready for its long or short sleep, according to the protection or exposure, the heat or cold, surrounding it. It is the seed, that chance may throw on stony ground and it will perish, or it may fall in some sheltered spot and there be preserved through any winter. The cause of so few appearing in spring may, and I think does, result from the fact that so few chrysalids fall into nooks or places suitable to protect them through the winter, and are destroyed by winter's cold or their own decay.

I suggested that perhaps the plant on which the egg was deposited might give direction or impress the worm with desire to eat of that plant. I am ready to change or modify my views, and say that now I think the plant on which the worm feeds must have the effect to determine the plant for the future worm.

I have observed this year that the Cotton Worms, after finishing the cotton, attacked the crab-grass, and have eaten it up—nothing left in the corn field for stock to eat; looks like a frost had killed it. These worms *did not retain their cotton-leaf color*, but underwent a great change; the black streaks were obliterated and green color took its place; the half-grown worms became stouter and shorter and more sluggish and of a dirty green color.

The change in the worm is so great that the identity of the worm has been most stoutly denied by very good farmers, who have said, "if you examine them closely you will find them to be the genuine 'grass' worm." If all things work according to my views, we shall be visited by "grass" worms next spring, which will eventually attack the cotton.

9. A large and strong light carried slowly through the fields will surely destroy the moth; but this must be kept up once a week, and the moth must be startled from its rest.

13, 14, 15. Paris green cheapest, used in powder; if too strong, will kill plant and any animal that will eat the plant. Should be used only sufficiently strong to kill worm and not damage the plant. Animals should not be allowed in fields where Paris green is used.

In regard to the answers herein given, my aim was to get the farmers' individual opinion unbiased, and after taking it down would read it, and ask if I had expressed him correctly.

P. S. CLARKE.

C. V. RILEY, *Chief U. S. E. C.*

Question addressed to farmers of Waller County, Texas.—What is your opinion as to the manner or mode of perpetuation, or preservation of the Army or Cotton Worm from one year or season to another? In what condition does it hibernate?

Answer by J. A. PEEBLES.—The miller, or fly, makes its deposit of "eggs" in the

fall in the ground; they hatch out in the summer, these eggs reproducing the miller. The miller subsists on some kind of food. Believes in a male and female fly, and copulation.

Answer by Dr. J. J. PERRY.—Believes it is propagated in the chrysalis from the chrysalis burrowing in the ground, there remaining intact till the period of incubation has expired, when the moth appears. Duration of incubation from six to nine months. Thorough system of winter plowing would eradicate them.

Answer by JOHN PEEBLES.—Believes the eggs are deposited in the ground by the fly; there remaining till cold weather is over, when they hatch as a fly. They (the fly) subsist on some kind of food while existing; they copulate.

Answer by A. T. BEDELL.—Some of the eggs remain unhurt by the winter and are hatched out in the spring, and in this manner are perpetuated.

Answer by Dr. L. W. GROCE.—Believes the eggs are deposited under the bark of the cotton-stalk, under and at the ground, and in this manner lie dormant through the winter and hatch out in the spring. No copulation.

Answer by J. C. RALSTON.—The fly deposits its egg, which becomes a worm, which becomes a chrysalis, which becomes a fly, which again deposits eggs. The fly does not eat. The egg is the medium of perpetuation, which holds through the winter in a capsule.

Answer by Dr. WILLIAM CLINTON.—The flies or moths are brought from the perpetual cotton fields of South America by strong southern breeze. Each year terminates them, and again are brought by southern breeze.

Answer by FRANK COOKE.—Originated in Southern States, is a hybrid or cross from common grass-worm; deposit their eggs on cotton stalks or in the ground, from which comes the first crop, these eggs lying in the ground till spring. Can be destroyed by deep plowing or freeze.

Answer by Dr. R. C. WATSON.—The moth deposits eggs on leaf, hatches in worm, then goes into chrysalis; depends on peculiar conditions how long it remains in this state, from which comes a moth. The chrysalis hibernates, the fly copulates.

Answer by R. G. WHITE.—The chrysalis drops from the stalk and becomes covered under ground; in this manner is preserved during the winter. The moth copulates.

Answer by B. F. ELLIOTT.—Believes the caterpillar goes in the ground in the fall; then becomes a chrysalis; remains dormant till next summer, when it hatches out a fly. The fly eats, copulates, lives three or four weeks.

Answer by ZACK WOOLEY.—The moth deposits eggs in the fall, which are preserved through the winter and hatch out a worm in the spring, which attacks vegetation; then go to work, web up, and turn to the miller again, which deposits eggs; these eggs hatch out the worm that goes to work on the cotton. The fly eats, copulates, lives three or four weeks.

Answer by M. G. STANLEY.—The caterpillar itself deposits eggs in the ground in the fall. This egg becomes the miller. The fly copulates; does not eat.

Answer by W. W. MOORE.—The worm passes into chrysalis and in this condition remains till spring, when it emerges a butterfly. No copulation; no eating.

Answer by A. A. PETTUCK.—The worm goes into the ground; there changes to chrysalis and remains till spring, when the butterfly comes forth to deposit eggs to start the worm; fly copulates and eats.

Answer by W. J. BUCHANAN.—They go into the stalks of cotton or small stumps at or near the ground; there they stay as a worm until we see them as a fly in the spring. The fly copulates; lives upon juices of flowers.

Answer by WILLIAM AHRENBECK.—They pass into the ground in the chrysalis state; there remain during winter, become perfected by spring, and come out a fly in spring; must be male and female; do not eat.

Answer by DANIEL LOGGINS.—They go into the chrysalis and remain in that condition till next year, when they come out a butterfly; copulate; do not eat; fly lives four days.

Answer by Dr. R. H. BOXLEY.—They pass into chrysalis state, and in this manner hibernate, when they emerge the next year a fly. The fly copulates, but does not eat; lives three days.

Answer by N. K. ALSTON.—The caterpillar deposits eggs in the ground in the fall; they lay there all winter and come out a fly in the spring, which deposits eggs to make the worm. Male and female fly; copulate. They must eat; fly lives two or three months.

Answer by JAMES LOGGINS.—The caterpillar changes into some other insect—don't know what this is—which hides itself till spring and then comes out a fly; fly copulates; feeds on something; lives nine days.

Answer by JOHN LOGGINS.—The caterpillar burrows in the ground in the fall; it changes there to chrysalis, and in the spring comes out a butterfly; fly copulates; lives on juices of plants; exists about twenty-one days.

Answer by J. F. GROCE.—The fly goes into the ground or secretes itself in some hidden place in the fall to protect itself from winter's cold, and comes out in July and August to deposit eggs; no copulation; no eating by fly.

Answer by JOHNSON HENSLEY.—A small butterfly lays its eggs in the fall in old trash, leaves, or bark of cotton-stalks. These eggs remain intact during winter, and in months of June and July hatch out the worm. The fly copulates and eats juices of vegetation. First saw the worm in Washington County, Texas, in year 1834, on Milk Creek.

Answer by WALLER COCHRAN.—The caterpillar burrows in the ground; there changes into chrysalis, and in this condition stays till proper time to hatch out a fly. The fly copulates; does not eat; live two or three weeks.

Answer by J. D. MITCHELL.—They remain in chrysalis state in any place suitable to protect them during winter; in spring it comes out a fly, which deposits eggs; fly copulates; subsists on juices of plants; live fifteen or twenty days.

Answer by H. LEWIS.—They go through the winter in the chrysalis state. After eating up the cotton (1879) they took to the crab-grass in the corn-field and devoured it completely. Did not discover any change in the color of worm after eating the grass. The fly lives six or eight weeks.

Answer by Dr. E. MONTGOMERY.—The chrysalis is the medium of perpetuation during and through winter. The fly eats and copulates.

Answer by J. H. DAVIS.—The chrysalis for the most part turns out a fly, but sometimes a cross between a chrysalis and worm. This cross goes into the ground and into trash and lays there till spring, or a suitable time, when it comes out a fly. Sometimes, when the weather is not suitable, very few develop, and consequently we have very few worms. The fly does not copulate, and does not eat.

Answer by THOMAS ARMER.—The fly secretes itself in some warm place, where it hides till winter is over and warm weather comes to bring it out; male and female fly; copulates, but does not eat. Believes the worm eating up the grass is a totally different one from the Cotton Worm.

Answer by THOMAS RAY.—Believes they pass the winter in the chrysalis state; have frequently seen them plowed up out of the ground; male and female fly; fly lives about ten days. The worm now eating up the grass is a totally different worm from the Cotton Worm, it being of a green color and smaller.

LIVINGSTON, SUMTER COUNTY, ALABAMA.

September 5, 1879.

Maj. J. G. Harris handed me your circular and letter, with request that I should reply to the same. I herewith inclose my essay on destroying the Cotton Worm, written in 1873, which will give my answers to many of the questions.

1. This county was occupied by the Choctaw Indians till 1832, and was mostly set-

tled up by the white people in 1833, and rapidly cleared up and planted largely in cotton.

2. The first year of the worms was in 1842 (so far as I know), when they stripped the foliage from the cotton in September.

3. They are generally worse after a winter of even temperature, not very cold. Last winter was a very cold one, and the worms have worked about in patches through the two past months, but not extensively damaging the cotton, though the weather has been very wet, and the moths are now appearing in considerable numbers. We have them in damaging numbers one or two years, and then an intermission of two or three years, and sometimes alternating in different sections of the county.

4. Wet summers are much the most favorable for their multiplication. In dry, warm summers they do not multiply.

5. By the middle of May, but generally not till June, in their earliest but small generations. In 1873 the destructive brood—second or third generation—stripped the cotton of foliage in July and early in August; usually not till the last of August and September.

6. They generally appear earliest in "bottom lands" and prairie, where adjoining thick-set wood lands.

7. They hibernate in the moth state; and also the very late formed chrysalis exist in that state through the winter, where protected from severe cold by grass or other herbage or covering, and perhaps in the ground.

8. All our insectivorous birds consume the worms, and the moths to some extent, but which are not out on the wing except at late evening and at night, or at a dark, cloudy evening.

9 No methods to destroy the moths have proved effectual; but fires attract them most, when some are burned or their wings disabled, and molasses will stick and hold some when attracted by a candle standing in the plate or vessel. This is the only known means of destroying the moth of the boll-worm, and preventing the great damage to the cotton-crop by their more obscure depredations, and might be effectual to lessen them much by the persistent use of great numbers of these plates of molasses, with lamps or lanterns so made that they could fly into and be burned, and thus destroying them before laying their eggs in the cotton-blossom. But sugar or sirups do not perceptibly attract by themselves.

10. These things are only useful in plates, when the moths are attracted by lights.

11. Know of no flowers which attract the moth, except the cotton-blossoms attract the moth of the boll-worm, in which it deposits the eggs, one in each blossom; and these blossoms are expanding from early June to September which perfect cotton, and thence on into October, but which are too late to mature.

12. Know nothing of the influence of jute grown near cotton.

13. Know nothing better than Paris green or cheaper than arsenic to destroy the worms, but have an essay, in pamphlet, published in 1874, on "the Texas Cotton Worm Destroyer," discovered and patented by J. D. Braman and A. Robira, "which is a salt of arsenic that readily dissolves in cold water," "four ounces of which, dissolved in 40 gallons of water, and costing 25 cents, and sprinkled over an acre of cotton with a watering-pot or sprinkling-machine, will effectually destroy the worms, and preserve the cotton." Patented by Robert Rennie in 1874. And they claim that it is better, safer, and cheaper than the other articles named.

14. Have not known of any injurious effects from the poison to men or animals, but heard of some through want of caution. The cotton leaves are quickly crisped and killed by the application of more poison than is necessary to kill the worms or in too concentrated a form.

15. The best methods of destroying the worms are given in the above answers and in my essay, and the most expeditious, with the cheapest, will be to use the poison in a dissolved form, and applied with a *fountain hand-pump*.

16. The cost per acre to protect a crop of cotton by killing the worms with poison

will be from 25 cents to \$1 and about half a day's work with the fountain hand-pump, to apply the poison in water, dissolved; or with sifters lined with muslin, to apply the poison in dry form, well mixed and incorporated with plaster or flour, when the cost of the flour may be added to the above-named cost, which was given only as the cost of the poison. What would be the cost of lamps, lantern traps, vessels, and material to destroy the moth, particularly that of the boll-worm, which does a vast amount of injury to cotton crops, or even to materially lessen the numbers, cannot now be estimated, as it has not been sufficiently tested. The fountain pump costs about \$5.

Respectfully,

Prof. C. V. RILEY.

I. D. HOYT.

PARISH OF CONCORDIA, LOUISIANA,
Lake Concordia, August 8, 1879.

1. About the year 1810 the planters of this parish and the adjoining county of Adams, most of whom owned property in both localities, commenced abandoning the culture of indigo and substituted that of the cotton-plant.

2. The first Cotton Worms or Caterpillars were noticed in 1840, both in this parish and in Adams County. They were noticed in August, cutting the cotton in rank spots. The second crop stripped the rank cotton in September. The appearance of an heretofore unknown insect caused a meeting of all the leading planters, and it was generally agreed that, owing to the luxuriant rank growth of the cotton stripped by the worms, that they were rather a benefit than otherwise, leaving the bolls exposed to the sun and thus insuring their ripening. The worms again appeared in greater numbers in 1844 and 1846, doing considerable damage both years, especially in the latter year, as they stripped every field in the county before maturity. They continued to appear in numbers at intervals up to the breaking out of the war, but, as the culture of the cotton-plant was pushed forward very early under the then existing system of labor, the yield was not much shortened by the stripping of the leaves in September, and many planters continued to think that the large cotton in new grounds, of which there was a considerable quantity, was benefited by the loss of foliage.

3. The character of the winter seems to have very little influence upon the propagation of the Cotton Worm; its development in greater or less numbers seems to depend *principally* upon the character of the summer season. A wet, rainy summer, causing a rank, succulent, growth of the plant, is peculiarly adapted to their propagation in countless numbers, even apparently shortening the period between their reappearance from 21 to 18 days, and causing them to appear in such numbers in what is commonly called the second crop (in August) as to almost destroy the leaves on the cotton and not leave sufficient foliage to sustain the next generation, in September, for more than half their allotted 7 days. For instance, the winter of 1872-'73 was one of the coldest known in this latitude for years. Worms were noticed in the latter part of May, and by the last of August the cotton-fields of this parish were perfectly bare, and yet still another crop of worms hatched in latter part of September, and destroyed crops saved by application of Paris green.

4. Wet summers are almost essential to the reproduction in any great numbers of the worm. Many of the eggs do not hatch in dry weather, and then the many enemies of the worm have a better chance to destroy them.

5. In 1868, the first year of my experience as a planter, I noticed a few in spots about July 15. August 7 they were quite numerous in spots. August 25 they reappeared, and injured the crop considerably; worms green, with two rows of yellow with black spots down back. September 8 a more numerous crop stripped portions of the field. September 25 the green, with black stripes down back, appeared, and soon stripped the plants of every leaf and small boll. In 1869 I found a few worms as early as June 24, full grown, pale green, marked with white and yellow spots. July 15 a few were noticed in rank cotton. August 7 they were quite numerous in spots of same

character of cotton. August 27 the green and black spotted worm "chopped" the leaves badly over whole crop, and successive crops appeared each week, September 2, September 8; and then on September 20 the green and black striped worm commenced stripping the crop. This was a very wet season, cotton growing very large, and despite the loss of leaves, the yield per acre was about one bale of 400 pounds weight.

In 1870 the season was one of the dryest ever known. I did not find worms until September 15, and then the green and black striped. They were not in sufficient numbers to do any harm. In 1871, the first worms noticed from 1st to 15th July, green; reappeared August 15, green, with black spots; September 10 appeared in considerable numbers, green, black striped, but did not entirely strip the plant; extremely wet spring, but dry summer. In 1872 the first noticed were on September 9, green, yellow stripes, black spots; reappeared July 15, all sizes and stages; August 20 to 25, heavy crop of green, black striped, stripping the cotton early in September. In 1873 found first worms latter part of May; had seen flies around buildings on warm days in February; did not pay much attention to their reproduction until July 25, when the green and black spotted ones appeared in considerable quantities. August 15 the green and black striped worms came in myriads, and made short work of the rank, succulent cotton, the growth of a rainy summer. I saved 900 acres by applying Paris green; 600 acres in one part of the parish was destroyed by October 1, the flies having been blown into my fields from adjoining plantations by a heavy wind the week previous; 300 acres on another plantation, being isolated, was not again molested.

In 1874 the first and second appearances were noticed latter part of July and August; September 4, considerable numbers of all sizes and grades; September 14, numbers sufficient to strip the cotton crop, as it was mostly planted after an overflow. Applied Paris green in places, but the worms disappeared, probably destroyed by birds and insects. In 1875, although not an unusually dry year, no worms were noticed. In 1876, found a few worms on July 12; August 2, considerable numbers in spots; August 22, reappeared in considerable numbers, all grades and sizes, but by September 7 they had mostly disappeared, it being very dry and hot, and birds and insects being plentiful. In 1877, noticed worms in July; August 10, good many; August 16, in sufficient numbers to justify use of Paris green in places, which saved that portion of the crop, but the worms reappeared in force September 20, and by 25th there was not a leaf left. In 1878, full-grown worms seen August 9, earlier broods not noted; August 21, full crop green, black spots, out over large area of the country, though not general; again used Paris green with success; September 12 to 19, cotton stripped. In 1879, the worm was first seen about June 20; about July 15 it was again observed, and now they are found through the fields in all parts of the parish, always the pale green, yellow, striped, and black spots. We look for a pretty full crop about 25th, and a destructive one about September 10, with continuance of this favorable showery weather, unless some natural causes, in way of birds or insects, prevent their propagation.

6. The Cotton Fly is a shy insect, and seeks shelter in large cotton, which grows in damp spots; there the eggs are deposited and the first worms hatched.

7. The moth hibernates between the bark of old logs and dead trees in the lofts of barns, gins, and outbuildings, protected between shingles, or in crevices, in a state of torpor. Only a few survive the rigors of winter; hence the very few which appear in the early spring. It is my impression that the moth is impregnated in the fall, but this is simply a matter of conjecture.

8. Nearly all birds and fowls devour the Cotton Worm with avidity, but the common black-bird, which to a considerable extent hibernates in this region and breeds here, is the greatest enemy among birds. The common red wasp, the small red ant, a species of large green spider that I have never observed except on the cotton plant, a hexagon shaped bug, green and sometimes brown (it being apparently of a chameleon nature), flat and emitting a very disagreeable odor when roughly touched, armed with a long, sharp bill which it carries under the body—commonly called the pump-

kin-bug—and lastly, the Ichneumon fly, all destroy the worm in its various stages of transition—the ant even taking the larvæ from the underside of the leaves. The wasp and Ichneumon fly, where numerous, seem to be most destructive.

9. The experiment of saving a crop from worms by destroying the moth was most effectually tried prior to the war when well-controlled labor was at hand and money was plentiful, and since then some enterprising men have spent much money and time in the vain attempt to save their crops by this means, but none in this section have succeeded. There are many, many times more worms hatched than necessary to complete the work of destruction; besides, my belief is that the moth deposits its eggs before leaving shade of the thick cotton, and having accomplished its destructive mission then flies about in the air.

10. The moth is attracted by the light, and my observation is that the vessels containing molasses, &c., being placed around the light, serve more to entrap than attract them. The moth is very destructive to fall fruit, puncturing it so soon as it begins to ripen.

11. Have never noticed moth about flowers.

12. Have never seen the experiment tried.

13. Arsenic itself is used by some persons, they claim, successfully, and of course, as it only takes about one-quarter of a pound to an acre, it is the cheapest poison that can be used; but owing to the great weight and the perfect insolubility of arsenic with water, I have found it a very unsatisfactory application; first, unless incessantly stirred and shaken it precipitates and clear water is applied, and the Cotton Worm lives on.

Secondly, if too much is carried in suspension on to the cotton it burns all young bolls and leaves. The Texas Worm Destroyer, a salts of arsenic, has considerable reputation and does dissolve in water, but, individually, I have been unable to attain the happy medium of mixture—either the worms are not killed or the cotton is much burnt when applied strong enough to kill. A solution of arsenic known in this section as “Early Bird,” and which dilutes readily with water, has the same objection—it has to be made too weak to kill worms or it kills worms and burns cotton at the same time. Hence I find myself compelled to adhere to the Paris green, even when run up to 75 cents per pound, as was the case in 1873. Have tried sundry other poisons without effect. Am now having prepared several solutions of Paris green with ammonia for experiment. As the great trouble is that Paris green will not dissolve in water—being only held in a state of suspension and precipitating so soon as the water ceases to be agitated—the water into which it is put has to be constantly stirred, and the 2-gallon pots from which it is sprinkled have to be constantly shaken violently; therefore we have been, so far, unable to use any mechanical process of sprinkling.

14. When applied too strong, say in greater proportion than 1 pound of green to 40 gallons of water, or 6 pounds of green to 200 pounds of flour and land-plaster, the mixture will burn and kill young bolls, forms, and tender leaves, and thus do as much harm as worms. Occasional instances of men being nauseated while mixing the green with flour and plaster, or even while sifting it on the plant, have come to my notice; but a single dose of the antidote, hydrate oxide of iron, always gave relief. A good many instances occur of men becoming chafed by riding, and the flour mixture and even the water getting on their persons causes soreness, and sometimes swelling of the parts accompanied by an eruption of white pimples; but this is soon relieved by the use of the antidote externally or an occasional application of sweet oil and sprinkling of flour. This trouble is prevented by use of oil-cloth aprons and free use of strong soap after working with the mixtures. Mules are sometimes made sore around and under the tail and on flanks and shoulders if care is not taken to wash them clean of the flour mixture, which becomes caked in the hair.

15. I have found the application of Paris green the surest poison for destroying the worm, applied in the early morning and late evening, mixed with flour and equal parts plaster of Paris and land plaster, 6 pounds green to 200 pounds, carefully and

thoroughly mixed and sifted before using, and then sifted on each side of the row through a No. 24 sifter, and during the heat of the day when the leaves are dry, $\frac{1}{2}$ pound to 1 pound green to 40 gallons water, sprinkled on each side of the row with a 2-gallon watering-pot, ordinary sized rose, perforated with holes about the size of a knitting-needle. The drawbacks the cotton-grower has to contend with are many. First, if the worms come early, say about August 1, in sufficient numbers to justify the use of green, the next crop, which comes about September 1, will destroy his crop, besides the work of cultivation is not completed. If they do not appear until 1st to 10th of September, he is then compelled to devote his time to picking the crop on sandy lands, and a loss of a week from this important work results eventually in great loss. If the worm appears in force about the middle of August the planter is then better prepared to destroy them, and the plant in a better condition to justify the expense; but often the weather is very showery, and much of the green is washed off, and the plant is partially stripped before the worms are killed; also, now that Paris green is so extensively used for this purpose, the article is very much adulterated, and while he pays less apparently per pound for it, it requires more of it to same quantity of flour or water, and even then it is not so destructive. Our great need is a *cheap, soluble* poison, which will dissolve thoroughly in water and kill the worm and not burn the cotton.

16. The cost of application, outside of first cost of the Paris green, depends upon a good many contingencies—convenience of water, size of cotton plant requiring more or less of the mixture to the acre. Where applied mixed with water and the water is convenient, as is generally the case in this parish, it will cost from \$1 to \$1.50 per acre. When applied mixed with flour and plaster (by far the most efficacious process) it will cost from \$1.50, at the lowest, to \$2.50 per acre. The best and surest plan for the cotton-planter to protect himself against the ravages of Cotton Worms is to list up his lands in December, and very early in January replot, plant early, and force the plant to maturity by constant, judicious cultivation. This mode costs as much per acre as the application of Paris green, but it is money better spent, as the soil is kept in better plight by such a process. Still, under favorable circumstances, I am a strong advocate for the use of Paris green, or any other efficient poison, to kill the worm, and use the green whenever my crops are threatened with injury by the worms.

Very respectfully yours,

C. V. RILEY, *Chief U. S. E. C.*

F. S. SHIELDS.

NATCHITOCHES, LA., *September 29, 1879.*

First, in order to answer your questions intelligently, I will give a slight outline of the geographical location and situation of the parish of Natchitoches. It is situated in the northwest part of the State of Louisiana, the greater portion being immediately south of the thirty-second degree of north latitude, its greatest length being from southeast to northwest. It had a population, according to the census of 1870, of 18,265. Had in cultivation last year, or rather in the previous year (1877), in cotton, 23,500 acres, and produced 13,940 bales of cotton. The lands are particularly fertile and productive, yielding the greatest abundance of the fruits of the earth with a small outlay of labor. As to your questions:

1. I answer only for the parish of Natchitoches, La. Cotton was first planted in this parish about the beginning of this century.

2. The first appearance of the worms in this locality was in the year 1823, late in the autumnal season, and they did but little damage to the cotton plant. The second time was in the year 1840, doing again very little damage, and creating no alarm in the minds of the planters; but when they came again, in the year 1844, they did considerable damage, causing serious alarm to those engaged in planting, making them ask the question if it would pay to continue the business. By the end of the month of August every leaf was stripped from the plant as if a killing frost had fallen.

After this, confidence was restored and cotton planted extensively until the year 1846, when again the crop was destroyed. The damage was considerable, and the yield lessened at least 25 per cent. After this no particular attention was paid to the worms until after the close of the late war, since which time they have reduced the yield year after year, until they became so destructive as to almost deter planters from engaging in the business.

3. In order to answer this question intelligently I have obtained the following facts in regard to the appearance of the worm from the year 1867 up to and including this present year, 1879.

Rain for the months of April, May, June, and July:

	Inches.		Inches.
1867.....	29 $\frac{1}{8}$	1874.....	17 $\frac{3}{8}$
1868.....	18 $\frac{1}{8}$	1875.....	7 $\frac{1}{8}$
1869.....	22 $\frac{1}{8}$	1876.....	9 $\frac{1}{8}$
1870.....	19 $\frac{1}{8}$	1877.....	20 $\frac{1}{8}$
1871.....	21 $\frac{1}{8}$	1878.....	15 $\frac{1}{8}$
1872.....	23 $\frac{1}{8}$	1879.....	16 $\frac{1}{8}$
1873.....	23 $\frac{1}{8}$		

As to the temperature of the months of December, January, February, and March, Dr. F. Johnson says: "As to mean temperature of these same months, the variation is too little to have any influence on the question before you. Compare your notes on Caterpillars, and see if you can find any mutual connection between temperature, rains, and worms. I do not think there are any satisfactory bonds of connection."

Caterpillars in—

- 1867.—First appeared about 6th of June; destroyed crop last of July.
- 1868.—First appeared 1st day of May; destroyed crop 10th of August.
- 1869.—First appeared 20th of June; destroyed crop 20th of August, partially.
- 1870.—First appeared 20th of June; destroyed crop 20th of August.
- 1871.—First appeared 15th of June; destroyed crop 20th of August.
- 1872.—First appeared 20th of June; destroyed crop 20th of August.
- 1873.—First appeared 10th of June; destroyed crop 1st of August.
- 1874.—First appeared 20th of June; destroyed crop 20th of August.
- 1875.—First appeared 20th of June; destroyed crop 20th of August.
- 1876.—First appeared 20th of June; destroyed crop last of August.
- 1877.—First appeared 20th of June; destroyed crop 20th of August.
- 1878.—First appeared 15th of June; destroyed crop 25th of August.
- 1879.—First appeared 20th of June; did not destroy crop.

4. This question is answered by the preceding answer so far as figures can, and from the statistics it appears that weather has no particular influence on them. You will observe that the months of April, May, June, and July, of 1869, were among the wettest of the caterpillar years, yet the crop was only partially destroyed, and for the same months of the year 1876 we had nearly two-thirds less rain and the crop was destroyed as usual. As to their destruction by the ants, that will be more fully explained later on. The plant during a dry spring is of very slow growth, and may not be able to furnish the necessary *pabulum* for the life and growth of the worm. This might be accounted one of the causes of a wet year favoring their development, there is more surface and food for them in a wet spring than in a dry one.

5. They have frequently been seen as early as the first days of the month of May, notably in the year 1868, when they appeared in great numbers in some localities, and did considerable damage to the cotton plant. Many planters were much alarmed at this early appearance, and thought themselves ruined again. The plant was, however, yet young and recovered from the damage, and a pretty good crop was made.

6. In the low moist places when the cotton is greenish and more tender.

7. The insect undoubtedly passes the winter in the butterfly form, which is the fourth and last stage of their existence. They belong to the species *Lepidoptera*, and genus *Papilio*, and are the proceeds of the chrysalides from the caterpillars. They are about seven-eighths of an inch long, of a dark greyish color, not so pronounced on the under side of their wings, with a characteristic dark circular spot on each wing. The last seen of the caterpillar in the autumnal season, when the crop of cotton is destroyed, is in the form of the chrysalis, for after they eat all of the cotton leaves they proceed to "web up" on any leaf that will afford them protection. This chrysalis produces the butterfly, which immediately prepares for hibernation. It is my opinion that they seek winter quarters before they mingle in concourse with the males, hence their eggs are not fertilized until after they come from their torpid state in the spring of the year. They may be seen in the warm days of January, February, or March, near the eaves of houses covered with shingles, or in corners of fences made of rails with the bark on them. Just before sunset, after one of these warm days, they will come out and fly around. At this time they do not possess the same brilliant colors that they do in spring and summer when they are depositing their eggs, and one not perfectly acquainted with them might mistake them for another species. They therefore pass the winter in the butterfly form, in a semi-torpid condition, yet, strange to remark, *en passant*, the first thing seen of them in the spring of the year is the worm itself.

8. First, birds (*Aves*) of various kinds and conditions feed more or less on them; among others I will mention the mocking bird (*Orpheus polyglottus* of Linnaeus). This bird feeds extensively on the Cotton Caterpillar (*Aletia argillacea*) in the early months of its existence; but they are not gregarious, hence their work is little appreciated in this direction, they not being disposed to go in flocks or localize or concentrate their destructiveness.

This present year (1879) the Cotton Worms have not developed as rapidly and as numerously as they have done usually heretofore, and among other causes retarding their progress has been pointed out as their great enemy the red-winged black-bird (*Agelaius phoeniceus*). This bird has been seen in large flocks in the cotton-fields very early this year. These birds have been seen frequenting our fields and forests in great numbers late in the autumnal season, but have never been known here in the months of July and August before. One planter told me that he saw one flock of at least forty thousand in the cotton-field! This number may have been considerably exaggerated, but there is no question that they have been in the cotton-fields during these early months, July and August, in very great quantities, such as have never been seen before. I have been informed that they feed upon the worms in three of their forms, the butterfly, caterpillar, and chrysalis. These birds should be protected and permitted to build their nests undisturbed by the hunter's shot or idle boy's hand. Many other solitary birds feed upon them, but their work is not appreciated.

As to quadrupeds, there are none known, with perhaps the single exception of the raccoon (*Procyon lotor*). He has been seen feeding on them, and planters inform me that they have seen the tops of the stalks bent and broken, evidently the work of the raccoon in search of the caterpillar.

Insects. Ants (family *Formicidae*, order *Hymenoptera*) have always been looked upon as one of the most inveterate enemies of the Cotton Caterpillar, destructive to them in all of their four different forms. They will detach the egg from the leaf and bear it off to their formicary; attack and kill the worm either in its active eating state or when under the torpidity of the second or chrysalis state, and if it is possible for them to capture a butterfly it shares the same fate. It may be owing to their inability to procreate and move about during wet weather that the worms are enabled to escape their depredations. It is a well-known fact that the female ant is winged, hence it is plain to be seen that wet weather will considerably interfere with their proper functional office. The female ants are furnished at their exclusion with two pairs of wings, which after swarming in concourse with the males they almost immediately cast. The office of the perfect or winged female is to provide a constant supply of eggs for the maintenance of the population. Rainy weather can therefore keep the female ant

"cribbed, cabined, and confined" to her prison life; if she is permitted to venture forth it is possible for her to be lost in the storm. The superabundant surface-water remaining after heavy rains will greatly impede the active operations of the "neuters," or working ants, whose office it is to supply and protect the colony.

The wasp (Genus *Vespa*, order *Hymenoptera*) attacks the worm, and will carry them off to feed their young, and should they be so unfortunate as to drop one on the ground, *en route* the ants will be certain to pick it up.

There is a small chinch-bug constantly found on the cotton-plant leaf, which undoubtedly feeds on the ova or eggs of the butterflies. They are not numerous, however, and are too small and insignificant to do any great amount of damage or interfere materially with the rapid increase of the worms.

9. The only effort ever made in this parish to destroy the butterflies has been by fires at night. They are easily attracted by the "glitter of a garish flame" at night, and great quantities can be destroyed in this manner. It, however, requires concert of action on the part of a large number of planters, which has never been done. As to attracting them by sugar, &c., it is generally believed that the butterfly does not take nourishment during its short life, or, if it does, the quantity is too small for them to be successfully poisoned.

10. They will be attracted only by the lights.

11. I do not know of any flowers that will attract them. They are not seen on any other plant than the cotton.

12. Nothing.

13. Nothing.

14. First, as to the plant: If the mixture is put on too highly concentrated it will kill leaves, blooms, and bolls. Second, as to man: When any portion of the cuticle is abraded and the mixture allowed to get on this particular place it is apt to cause local inflammation and inflammation of the neighboring lymphatic glands; no case, however, to my knowledge has ever been known to result seriously. Third, as to animals: I know nothing of any serious accident to them.

15. The best method yet tried is the application of the Paris green suspended in water, 1 pound to 40 gallons. The Paris green being the arsenite of copper, it is not soluble in water, and when the two are mixed the Paris green is only suspended; hence it is necessary to keep the mixture constantly agitated, otherwise some portions will be stronger than others, and will in that case be apt to injure the plant.

The mode of applying it differs according to the means of the planter using the poison. Many persons make brooms of the Mayweed (*Anthemis cotula*), which are handy and very convenient; others use the common garden watering-pot with the perforated nozzle, which is expeditious, efficacious, and at the same time inexpensive. The best mode yet found is with the fountain-pump; with this the work can be accomplished with neatness and dispatch without wetting the clothes of the one applying it. The poison must be applied just after the worms are hatched and begin to crawl, otherwise it will be too late. It requires careful looking to find the worms at this stage of their existence. Four or five days after the butterfly emerges from the chrysalides she begins to lay her eggs, on the under side of the leaf, and after about the same time the eggs begin to hatch; then look carefully under the leaf in the locality where you expected to find them, and almost to a certainty they are there. In order to better find them every planter should provide himself with a small magnifying glass, which will cost them only about twenty-five cents. This summer I had in my office one leaf from the cotton plant, and on it there were ten worms and in it at least one thousand holes, yet on handing it to several persons they failed to see either caterpillars or holes until they were pointed out to them.

By request I received the following letter from one of our largest planters:

NATCHITOCHEs, LA., September 26, 1879.

DEAR SIR: In 1876 I experimented with arsenic to destroy caterpillars, with the following result: 1st, I took one pound of 16 ounces of commercial arsenic, which cost

about 25 cents per pound, dissolved it by boiling in 8 gallons of water; after it was dissolved replaced the quantity of water lost by evaporation; with this 8 gallons I went to work. 1st. Put 2 gallons of the solution in a pork-barrel of water, say 33 gallons, sprinkled two rows of cotton; result of this application was death to both cotton and worms. 2d. I then used 1½ gallons to the barrel of water; same result to the worms, cotton badly scalded. 3d. I then took one gallon of the solution and put it in a barrel of water; this time my solution seemed to be a little too strong, but did no perceptible injury to the plant; the leaves retained their color except in places. A fourth application of three-quarters of a gallon of the solution to a barrel of water was tried and found of sufficient strength to kill the worms and not damage the plant. These experiments were made at the same time Paris green was applied to the balance of the cotton on the plantation, none, however, being used when the arsenic was applied. The rows in which the two last applications were made (*i. e.*, 1 gallon and ¾ gallon to the barrel of water), the cotton lived and bloomed about three weeks, at which time the worms destroyed all of the cotton on the plantation.

Respectfully,

H. B. WALMSLEY.

Dr. GEO. E. GILLESPIE.

The Paris green has been sold in this market for \$1 per pound, but it can now be bought for from 25 to 35 cents per pound. It is calculated that three-quarters of a pound will poison an acre; however, if the application is made just before a rain, it will be necessary to repeat it. Most planters think that \$1 per acre will cover all the necessary expenses.

Respectfully,

GEO. E. GILLESPIE, M. D.

C. V. RILEY, *Chief U. S. E. C.*

JACKSON, MISS., September —, 1879.

In answer to some of the questions of your circular No. 7:

4. Warm, wet, and cloudy weather favors the appearance and reproduction of the Cotton Caterpillar.

5. Never have known them to appear in the spring when June and July have been wet; the 1st August is about the earliest period in this locality.

6. In cotton of the largest growth without regard to the situation.

7. Observation has led me to believe that the worm in none of its forms lives through our winters in this locality, and also form an opinion in direct variance with science as taught in the schools. I have attempted to arrest their increase when only a few had made their appearance by destroying by hand, but without success; for suddenly, without the possibility of such an increase by reproduction, they would appear in such numbers as to destroy every leaf in two or three days. Again, in another instance, when no worms were in this neighborhood, four days after a diligent, and careful search, when no sign of them could be found, they suddenly appeared, and in three days not a cotton leaf could be found in my field except about one acre near the middle of it, which was planted much later than the rest, not a leaf of which they touched, although some of the branches interlocked; but some weeks afterwards when this patch of cotton had arrived at the same stage of growth it was also stripped of its leaves as the other. In all my observation, the worm when it has exhausted the supply of cotton leaf *will eat nothing else*, but crawls up on the weeds, bushes, and fences, and die.

8. From this experience, connected with the facts of their irregular appearance, and that only under the same conditions of wet, warm, and cloudy weather, which is always unfavorable for a healthy growth of the cotton plant, and that the worm never appears in the spring or early summer, at least, not in such numbers as to be noticed; its power of quick reproduction; its total absence from the cotton plant at that time when it could not escape detection; and the temperature of May and June always high enough for the development of the worm through all its forms, leads me to believe that the Cotton Caterpillar is the spontaneous production of diseased cotton plants.

9. All efforts to destroy and stop the progress of the worm when the condition for its appearance and increase is favorable, has proved futile so far as my experience extends in the cultivation of cotton for thirty years.

Yours, very respectfully,

H. O. DIXON.

Prof. C. V. RILEY.

LARISSA, CHEROKEE COUNTY, TEXAS,

October 13, 1879.

In answer to your 4th inquiry, viz: "Do wet or dry summers favor its multiplication?" I would answer that about ten years ago the Rev. N. A. Davis, now of Jacksonville, in this county, suggested to me the probability that the small red or brown ant, abundant in the South, was the natural enemy of the Cotton Worm and especially effective during dry summers. After two summers' observation, I was convinced of the truth of the reverend gentleman's conclusions. His opinion and two years' observation induced me to write the following to one of our county papers:

THE COTTON WORM (1871).

"The danger from the Cotton Worm is now over and we may review the history of its depredations during the summer. Only a few farmers have suffered save in the anxiety which they have felt during the maturation of their crops. If you recollect, the worm was worse during the few weeks following the rainy season; and as the dry season since advanced, the worm gradually receded and the hopes of the farmer revived. The first generation of these troublesome insects appeared to have taken place in the wettest lands early in the spring, and it was about the second generation that menaced the crops. Wet weather favors the increase of the worm and dry weather soon destroys it. This observation has been made by many farmers long ago. A similar observation has long since been made in regard to the Cotton Louse. Early in the spring (when the cotton is in its first and second leaf), if the weather is rainy, the louse soon covers the tender cotton plant and threatens to destroy it. But when the dry season supervenes the little insect disappears, and the plant soon recovers from the mischief. To what shall we attribute the disappearance of the insect in both cases? It is evidently due to that little predatory and almost omnipotent ant which retreats to its hole and gathers in large bunches in dry places during the rainy seasons; but whenever the drought sets in, it climbs the stalk of every plant in search of prey. It is carnivorous and deals death and destruction among insects in the crawling stage of existence wherever it goes. When the Cotton Louse multiplies dangerously on the tender plant, favored by a rainy season, the farmer loses all hope of his crop unless the dry weather comes and the little ant begins to milk the cows (the lice are called "ant cows") by climbing up to them and striking them with their hands and eating a fluid, which is made to exude from them, by the concussion. This process soon destroys them. Then, at a later season, especially if the ant is driven to its shelter by rains, the Cotton Worm, having increased to a dangerous extent, threatens the more mature plant. Again the same ant, when the sunshine permits, saves the cotton by climbing the stems and seizing the flouncing worm, cuts it into two on the ground, to which both have fallen in the struggle, and thus in a very short time it thinned out the worm, either destroying or holding it in abeyance.

"The history of these two enemies of cotton growers accords with the experience of observers. The dry weather, *per se*, does not save the cotton from louse or worm in the former or latter season only as it permits the predatory ants to destroy them; nor does the wet weather favor the production of the insect only as it drives the ants to their holes. Were it not for the ant the cotton plant would never make the first limb, or, escaping this, could not mature a single boll on account of its second enemy, the worms.

"Then let us curse the little biting ant no more when we happen to get a shoe full, but remember that we are indebted to this diminutive creature for every thread of cotton that has gone into the commerce of the world."

Thus you see that about ten years ago the Rev. N. A. Davis informs me of his discovery of the destruction of the Cotton Worm by the ant; to which I have added the additional fact of its destruction of the Cotton Louse earlier in the season by the same ant. The observation of each succeeding year since that time has confirmed me in the opinion, and our last summer, the driest I ever saw, yielded no specimens of the worm or louse within my observation. Please obtain the technical name of inclosed ant.

Yours, respectfully,

Prof. C. V. RILEY.

F. L. YOAKUM.

PERRY COUNTY, ALABAMA, *September 17, 1879.*

I beg leave to offer the following, in answer to your questions in regard to the habits of the Cotton Worm, and the best modes of destroying the same:

1. I can remember seeing cotton grown as far back as 1820 in Autauga County, Alabama. Since 1822 I have been cultivating the plant in Perry County on sandy land.
2. In 1837, about the middle of September, was the earliest I ever saw them. No damage of any consequence afterwards until 1866.
3. In my opinion, the worms are worse after a severe winter. I suppose it is because they come out oftener during mild winters and are consumed by the birds.
4. Hot, dry weather seems to be the life of them.
5. The 20th June is the earliest I have noticed them, but doing no serious damage until 20th July.
6. They invariably make their appearance first in the low, black lands of West Perry County.
7. They hide themselves in old barns and rotten trees during the winter, coming out in the afternoon of warm days.
8. The appearance of the worm does not seem to attract any kinds of birds to our fields but all domestic fowls devour them ravenously, as do also hogs and ants.
9. There has been no method adopted for destroying the moth successfully.
10. They are attracted in larger numbers by decayed fruit of almost any kind than by anything I know of (during night).
13. Paris green seems to be the most reliable mode of destroying them, though some of my neighbors have used London purple with good effect.
14. It is dangerous to men, animals, and cotton when used with indiscretion.
15. I have used kerosene oil, one part to thirty parts of water, effectually, and spirits of turpentine will do about as well. I believe pine sawdust sown *lightly* with the seed would be a preventive.

Yours, &c.,

Prof. C. V. RILEY.

O. H. PERRY.

WALTERBOROUGH, COLLETON COUNTY, SOUTH CAROLINA,

September 23, 1879.

I mail you this day my report, as requested by you in circular No. 7. This report is not as full as one I made last year to the department, but what I have said is founded on experience and close observation of the Cotton Worm for years.

Trusting that it may be of some use in your department,

I am, very respectfully, yours, &c.,

JAMES W. GRACE.

C. V. RILEY, *Chief U. S. E. C.*

1. Cannot state from any reliable authority, but cotton was grown soon after the settlement of the county for domestic purposes.

2. As early as 1793 the worm swept over the State, but it is first recorded in this district in 1800 as prevailing generally.

3. The worm is most to be dreaded after a mild, warm winter. He will make his appearance sooner in the following season.

4. Wet summers by all means favor its multiplication.

5. First of June.

6. In wet, low spots where the plant grows luxuriant, the plant being succulent, soft, and pulpy.

7. I believe that it is a peculiar parasite of the cotton-plant, and as such that the cryptic germ of the insect is to be found with the germ of the plant itself, and, like all parasites, only requires favorable circumstances to develop it; a soft, pulpy, and luxuriant state of the plant, with cool and cloudy weather at the time of its natural advent—that is to say, from early in June to middle of July—will cause it to develop vigorously and bud rapidly, so as to produce seasons; whereas dry June and hot weather, causing a hard, dry state of the leaves and mature condition of plants, furnishing but little and poor food, will result in a poor and a feeble brood, too inactive to do harm. This theory is borne out by the following facts: The Cotton Worm is found everywhere on the globe where cotton is planted, and only found on the cotton-plant. The worm will starve if the cotton-plant fails, though other vegetation abounds. When the plant is pushed on so as to grow and mature rapidly, the leaves being hard and dry in June, as was usual before the war, we hear nothing of the worm; but when cultivation is bad, the plant backward, and when June, the time of its natural development, comes, the worm finds the cotton (as since the war) green, sappy, soft, then does it rejoice in wholesome food, increase rapidly, multiply, and make itself a scourge.

I do not believe that the worm is migratory and returns to us from a warmer climate every year, for it can be found every year in small numbers if sought. I cannot admit this view, as I have seen it 300 miles from the coast at an elevation of 1,500 feet, in the northwestern corner of this State, in the month of June, and observed it there till the fields in August were totally destroyed. How could I believe that it got there by migration or was carried by currents of air? Nor can I believe that it hibernates around, as under old fences, on the south side of stumps, &c., as, first, our winters are too severe to render such a supposition plausible; and, again, since the late war, no fences exist to give such shelter on the islands of our coast, where the worm most prevails, and the universal fires that pass every fall over woodland and clearings would effectually destroy any moths or chrysolids.

Therefore it is clear to my mind that it is a peculiar parasite of the cotton-plant, and the cryptic germ of the insect is to be found with the germ of the plant itself.

Last year I made a very full report of this matter, and am sorry to learn that it was made no use of, and probably consigned to the paper-*mill* without being read.

8. Most all birds, such as the mockingbird and others, seem to be fond of the worm.

9. Paris green is the only thing that I have seen used, except fire-stands about the field. The latter is useless. Paris green is good, and the only thing I know of that will destroy them.

10. I should say near fire-stands.

11. I don't know of any.

12. Nothing.

13. There has nothing been found better than the Paris-green to destroy the worm.

14. I have not. With care there is no danger to man or beast.

15. Good cultivation. Push the plant early in the season.

16. The cost of keeping a good man and paying and feeding good hoe-hand, and this is the best means, and the cost is not very much.

JAMESTOWN, ALACHUA COUNTY, FLORIDA,
September 16, 1879.

In answer to your circular questions, the following is respectfully submitted:

3. The worm is most dreaded after mild winters.

4. Much rain in June and July seems to favor their development; but the character of the rains in those months in this section are short but frequent showers, with bright sunshine between showers. The writer has come to the conclusion from some observation that continued cloudy days are unfavorable to the development of the worm, and these reasons are given: Continued cloudy days are unfavorable to the hatching of the eggs; the sunshine seems to be needed with its greater heat. In cloudy weather the flies or moths will be on the wing throughout all hours of the day, thereby giving the birds and mosquito-hawks better opportunities to catch them. In such weather the worms stay on the top side of the leaves throughout the day, and consequently are more readily seen and caught by their enemies; while in hot, fair weather the moth is concealed during the day, and does its work in the twilight and at night, when the birds and other enemies are at rest. The worms, too, of the first crops seem to work or eat only in early and late parts of the day, and probably at night; generally from 8 or 9 o'clock a. m. till 4 or 5 o'clock p. m. they will be found quiet on the under side of the leaves. It is the belief of the writer that continued rains, with cloudy days, are unfavorable to the increase of the worm; cloudy days, even without rain, are unfavorable.

5. Have never seen the worm earlier than June.

6. Generally is seen first in moist, rich spots, where the cotton grows rapidly.

7. Have seen the moths at various times during the winter as "candle-flies." Suppose that those worms that come to maturity when winter is approaching, by instinct seek some place protected from cold, and, if not disturbed, might remain in chrysalis till the proper amount of heat would develop them into the moths. Those that are badly or slightly protected from cold may either be frozen by cold weather or warmed into life by a few warm days, while those that are properly protected, which probably are but few, will pass through the winter, and be revived only by the hot sun of May or June.

8. Almost all domestic fowls will eat the worm. Geese will eat them to some extent, while chickens, turkeys, guinea-fowls will grow fat on them. Almost all wild birds will eat them, and a large wasp, both black and red varieties, seem to be fond of the worm. In this section there are great numbers of a lace-winged fly, commonly called mosquito-hawks. These are of various sizes and colors, and are very expert in catching the moth on the wing. I believe this mosquito-hawk is very influential in preventing the progress of the worm.

While on this question I would like to state that it is my opinion that much good could be accomplished, and probably many fields might be saved, if birds that are insectivorous could be domiciled in the field. From what I have heard of the English sparrow it occurs to me that this would be the bird for the purpose. If bird-houses are located in various parts of the field, the birds would naturally hunt for insects near their homes, and the consequence, I think, would be that in all cotton-fields well supplied with these birds, the caterpillar would be kept down. If the English sparrow can be domiciled, that is, will stick to its house and feed around, it could be made of great benefit to the cotton region. The suggestion is offered for your consideration.

Very respectfully,

F. M. McMEEKIN.

C. V. RILEY, *Chief U. S. E. C.*

SAN ANTONIO, TEX., *September 11, 1879.*

I shall not answer your questions as I find them in the Herald of this city, for I presume there will be plenty of answers for you. My object is to state a fact bearing on the Cotton Worm. I planted cotton in the State of Nueva Leon, Mexico, five leagues below the city of Monterey, in 1867. Cotton had never been planted at the place, nor nearer than 200 miles to it in this world's history. I brought the seed from San Antonio, Tex., the ordinary Petit Gulf seed. The genuine Cotton Caterpillar appeared in the last days of May, and by the end of June ate up the crop. In the city of Monterey, at the same time, I planted in my garden (a large one) two patches of cotton—one the Texas seed, the other the black seed of the Sea Island genus, that is generally planted in Mexico. The distance between the two patches was, say, 200 yards. I received a note from my partner at the hacienda below Monterey, about ten o'clock in the morning, telling me that he had discovered the worm in the cotton field. I at the moment passed into my garden and *found the worm in both patches.*

Now, the question is, where did they come from? The egg or germ could not have been in the seed, as the butterfly cannot reach the seed to lay her eggs, and the gin would have destroyed them. I assert that they could not have been blown there, or have remained deposited in the earth from the creation thereof; yet they came. The weather was showery, hot, sultry, and between showers a hot sun. I have planted cotton all my life; have noticed the worm, and have always found them to come after such weather as I describe. When you walk between the rows after a shower, and a sort of hot steam vapor comes up, then look out for the butterfly. I also planted cotton in the Laguna, or Rio Nazas country, in the State of Durango, Mexico, in 1873-'74-'75-'76, where we plant the black seed but once in five or seven years; as a general thing the same Cotton Worm to which I have been accustomed in Texas, came every year; but, as there is but little rain there, they seldom come before September, and too late to do much harm. Scientists say there is no original creation possible now; that all things of this world had their beginning when it was made; but I believe that the atmosphere created the germ right there. When I was a boy there were no cotton worms; now they never fail. These are points to which you are devoting your time, and so fraught are they with the interests of our people, that all will wish to aid you as they can; and I write this to state a fact, but which I know will add to your difficulty.

Respectfully,

H. P. BEE.

Prof. C. V. RILEY, *Chief U. S. E. C.*

SAN ANTONIO, TEX., *September 29, 1879.*

You do not agree with my theory, but it will bother you to find out where the Cotton Worm came from, under the circumstances, as stated in my previous letter.

There is no cotton growing *wild* in the part of Mexico where I resided, as there are heavy frosts there every winter; in the tropical region of the State of Vera Cruz, and to the south, large crops of cotton are raised, but I never saw a *wild* cotton plant.

The consul at Vera Cruz could, I have no doubt, give you an interesting account of the cotton plant in his section. I know that in the neighborhood of *Paso del Macho*, on the Vera Cruz Railroad, the cotton is bent down so as to stand the storms, and consequently the plant grows horizontally instead of perpendicular, and presents a curious appearance when ready to pick.

Some years ago there were large fields of cotton in the State of Coahuila, in the district of Monclova, but although admirably adapted to the production, the Cotton Worm from successive visitations entirely broke up the business, and now no cotton is planted in that State.

I planted cotton for four years on the Rio Nazas, or Laguna Country, in the State of

Durango. This is the *Nile* of America. The Nazas rises periodically (always once a year, sometimes oftener), and overflows a vast extent of country, a bold, clear, mountain stream, 200 miles long, finally emerges from the mountains into an immense plain. The banks become lower as the river descends, until by many mouths it winds its way into the lake or laguna, a body of water 90 miles long and 35 wide, with no outlet—a great body of fresh water on an elevation of, say, 3,000 feet, in the midst of a great dry desert. The water of the lake is not utilized, as the soil on its banks is poor, no alluvial deposit or growth denoting original formation, but rather that the lake had been produced there by some convulsion of nature, as, if it were the original deposit of the waters of this great river, there would be swamps and sluices and timber denoting that fact, as the mouths of the Red River and other streams in Texas and Louisiana. The haciendas of the laguna begin where the River Nazas emerges from the mountains, and is utilized by dams and canals and ditches, by which the overflow is restrained and the lands irrigated. This irrigation is seldom used more than once a year, as the extraordinary character of the alluvion deposit of centuries retains moisture sufficient to produce crops for two years if necessary. (It seldom rains, and rain is not depended on at all for crops.)

Cotton is planted once in seven years; is planted with a hoe. A hole is dug from 12 to 18 inches deep, to the moisture, the seed deposited, and that is the start, which is expensive, but there is no other way, as the moisture is too low down to be reached by a plow. The cultivation is as with us: Frosts kill the plants, the stalks are cleared off and burned, and in the early spring with the budding of the peach tree the cotton sprouts, and gives you a start of three or four weeks over seed just planted. The "Planta" gives the best yield the third year; gives less, but a good crop, the fourth and fifth; and then produces as in the first and second years. The seed planted is the *black seed*, like the Sea Island and Egyptian; staple long and fine. The green seed, or American cotton seed, yields the first year better than the black seed will on the third year, but as that seed will not ratoon or grow again from the roots, and the expense of planting is so great, it is not generally used. Cotton produces a bale to the acre; corn and wheat, most extraordinary crops in these rich alluvials.

Cotton is planted at Santa Rosalie, in the State of Chihuahua, but not to a great extent; the climate is most too cold. This gives you all the information I have about the cotton region. With the exception of the Nazas and the Santa Rosalie, no cotton is grown in Mexico, except in the tropical regions of the Atlantic and Pacific coasts, as the rest of Mexico is generally table-land, with an altitude of from 3,000 to 7,000 feet, and a temperature too low for delicate vegetation.

There is a mountain in the center of this vast alluvial plain of the Laguna. In caves in this mountain are to-day the bodies of an extinct race of Indians, of whose existence in this plain there is no history extant. The bodies or mummies I have seen; they are wrapped in a species of cloth or matting made from the maguez, painted, and all in good preservation; the skin has dried, the hair is perfect; all in wonderful preservation. No iron, gold, silver, or other metal has been found in the cave. Pottery ware, of the same shape as the pictures we see of the old Egyptians, arrow-heads, and spear-heads of flint. It really is remarkable, and induces the belief that some sudden overflow of the river submerged the plain and drowned all the people; they were evidently used to high water, as they buried their dead in the caves of the high mountains. There are thousands of mummies in these caves. Excuse this long letter.

Yours, respectfully,

H. P. BEE.

Prof. C. V. RILEY, *Chief U. S. E. C.*

KIRKWOOD, MISS., September 5, 1879.

1. The cultivation of cotton, I am informed, was coeval with the settlement of the country. I settled here in 1845 and found cotton cultivated all over the county.

2. The boll worm has been an annual visitor since the first cotton was planted, destroying more or less, according to the character of the season. Though I had heard of the visitation of *Aletia* previously, I first observed it in 1858, though it did but little damage to crops that year.

3. It is more dreaded after a mild winter, but its visitations do not seem to be influenced more by one than the other; that is, they are as often seen after one as the other.

4. Cannot say that a wet season favors its multiplication. They are never developed during hard rains or continued wet spells. Their propagation seems to depend upon showery weather creating atmospheric dampness, and a high mean temperature. Dry weather is unfavorable to their production or increase.

5. The last week in July is the earliest period. Have often found, what is here called the grass worm, as early as May, eating both grass and cotton.

6. Its first appearance, in my observation, is along hillsides, where moisture is retained, and hollow spots on upland, just where in plowing after a season the plow encounters the wettest soil; such spots as generally produce the most luxuriant cotton.

7. About the middle of last November, and after several severe frosts, I found many chrysalides, of the last brood, on bare cotton stalks, living and lively. I placed these with others, previously brought in, in glass jars and boxes with earth and rubbish, exposed to outer air. Between the 15th and 20th of January, after a severe freeze of several days' continuance in December and January, a number of living moths came forth, in a warm spell then prevailing, but soon died. On the 6th of February the whole lot of chrysalids were then examined, when many were found to be dead and dried up, others again looking plump, which were inadvertently thrown away, and from the cases of others several varieties of living ichneumon flies were taken alive. One of them filling the case, and of normal size, was sent to Professor Riley and pronounced by him to be "*Pimpla conquistator*," a parasite of *Aletia*. My impression now is that had they been left undisturbed the living moths would have issued forth this spring from a few.

I do not think the moth can survive the winter, as in its natural state and in confinement it is so short-lived in the summer, and my conclusion is, that though it may be retarded in its transformations in our climate by cool weather, it was not designed by nature to hibernate in any of its phases, but is the creature of a semi-tropical climate, where it is perennial and completes the cycle of its existence uninterruptedly. It has followed cotton, its favorite food, into our temperate climate, has become indigenous, but has been subjected to abnormal changes, and only appears in large numbers during those periods when our climate assumes for a time a semi-tropical aspect.

Many of the moths leave their cases late in the fall, and many eggs as well as chrysalides are caught by the frost upon the cotton stalks and must necessarily fall to the ground with the detritus of the plant, and where there is much vegetable matter, as is the case in our fresh lands, and from the decomposition going on, would be well protected against frost. What goes with the moth, unless it dies, is a mystery, as I have rummaged everywhere without success, and in spite of rewards offered can hear of none from one season to the next. The general opinion is that they die out.

As the egg of the *Aphis*, a much more insignificant insect, but one greatly affecting cotton, is known to survive the winter, by analogy I do not see why the egg of *Aletia* may not likewise survive. The one, *Aphis*, is deposited on the stalk, and the other, *Aletia*, on the leaf; both go to the ground. *Aphis* appears almost coetaneously with cotton under its appropriate law, and why may not *Aletia* appear later from its ovum under its appropriate law?

8. Starling and a species of gregarious blackbird; ichneumon flies, and also a small, velvety-looking caterpillar, black, with two lateral yellow stripes.

9. Poisoned sweets near lights for the destruction of the moths were tried here many

years ago, and with some success. It was soon abandoned on account of the time and trouble, as well as expense, and has never been repeated. A moth-lamp attracted attention a few years since about Canton, but that, too, has flickered out.

10. Light would prove far more attractive than the sweet.

11. I know of no flower which attracts them.

12. Nothing.

15. As we usually, in fact invariably, see the worm before we see or hear of the moth, the aim would be to destroy the second brood, and this could be best done by putting out lights and sweetened poisons to attract the moths.

I will here reiterate what has been submitted in previous correspondence, that the propagation of the worms in destructive numbers is the result of imprudent tillage, and that by plowing wet land we hasten their production by an artificial process which good husbandry would teach us to avoid. He who will run his plows only when his lands are in good tilth, and the work will prove advantageous to the plant cultivated, will never have his cotton injured by the invasion of the Cotton Worm. I deem it unnecessary to go into detail, as my theory and plans have been elaborated in previous correspondence.

I have the honor to be, yours, respectfully,

E. H. ANDERSON.

Prof. C. V. RILEY, *Chief U. S. E. C.*

[Dr. Anderson's theory, referred to in the above report, and as set forth in an extensive correspondence, may be thus stated: In 1858, in the month of July, on visiting his cotton field early in the morning, he found his overseer running a number of plows on a hill side adjoining bottom land, where the soil was wet. He ordered the plows to be stopped, believing that the work would fire the cotton and cause it to shed, and perhaps injure the land by baking the wet sod in the hot sun. In ten days the worm was discovered in the cotton, and in twenty days there was not a leaf or young boll to be found upon it, and what especially surprised him was that the worms did not touch adjoining cotton or cross the plowed furrows. Since that time he has often witnessed a similar occurrence, and others have had a like experience, so that he gradually came to consider that there was cause and effect. He made experiments which seemed to confirm that belief, and finally reached the conclusion that, either the moth, unobserved, had deposited her eggs upon the stocks, or the eggs of the previous season had fallen to the ground with the leaf of the plant and, being protected by the detritus, had survived the winter. To use his own language:

"Under ordinary circumstances, from the albuminous nature of the egg, it would be affected by heat and moisture naturally; that is, by solar action on rain and dew, creating vapor, which quickens it into life, by inducing fermentation and putrefaction, without which no egg could be hatched and no germ vivified. Under the influence of cold these chemical forces would be dormant, and the embryo or germ would remain quiescent. The necessary atmospheric conditions do not recur annually for the speedy propagation of the *Anomis*, and hence we do not have them in destructive numbers except in propitious seasons. * * * It is a fact, patent to all practical farmers, that, if their land is plowed while wet or too wet for good tilth, the corn or the cotton, as the case may be, is injured thereby—fired, as it is termed; the corn turning yellow and being arrested in its growth, while the cotton sheds its leaves and droops. Why is this? I should say because the clod is exposed to rapid solar evaporation, and the hot steam damages the plants, through its respiratory, and impedes the normal functions of all of its organs by disturbing the healthy equilibrium of the air. That an abnormal degree of heat is produced by this process is proved by the application of the thermometer, as I know by experiment; and every farmer knows that the hottest and most oppressive work is plowing wet land under a hot sun." It cannot need proof to show that when by plowing you disturb the capillarity of the earth while damp, abnormal heat is produced by the more rapid evaporation of the upheaved soil. This is as certainly true as that a shower, by restoring or re-establishing capillarity, will cool down the earth.

"Now, my theory is that the damp artificial heat produced by the process of plowing wet land is the most favorable of all conditions for hatching speedily the eggs of the insects, and especially when you add to this the extrication of ammoniacal gases, which under such circumstances must be more abundantly evolved. This I hold to be the solution of the mystery of speedy generation in the wetter portion of cotton fields."

The plan of prevention Dr. Anderson proposes on this theory is, never run the plow in May and June south of his latitude, or in July and August farther north, when the land is wet and not in good condition for plowing. If there are frequent rains, he believes it matters little when or how the plowing is done; "for so long as the rain continues, the necessary physical conditions cannot be produced—shower succeeding shower in rapid succession keeps the temperature of both air and earth cooled down and is inimical to the worm. When, however, showers at longer intervals occur, and the temperature is high, and the plowing produces rapid evaporation, and the plowman, reeking with sweat, pants for a breath of pure, dry, fresh air, then the *Anomis*, nurtured into life by its genial surroundings, commences its revels, and in a short while the luxuriant cotton is converted into bare and blackened stocks."

"You must make cotton as you make hay; that is, while the sun shines. The diligent farmer who keeps even with his work can always afford, without detriment to his crop, to let his plows rest until he can do good work; but if plow you must, to kill grass and the rain won't stop, throw your furrows into the middle of your rows and not to your cotton, as by this process the danger of developing the worm is less, and no injury is done to your plant."

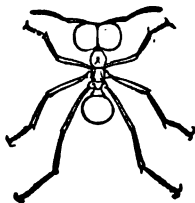
Dr. Anderson, nevertheless, admits that "a few of the insects are annually hatched by a natural process; enough to perpetuate the species." A similar theory to this one of Dr. Anderson's is held by a number of planters, founded, of course, on the observed influence of soil and weather on the development of the worm; but in so far as any such theory implies the hibernation of the egg, or the spontaneous generation of the insect, or in so far as it departs from the reasoning on pages 18-19 of this Bulletin, I believe it to be fallacious.]

[The following condensed summary of the habits of the worm is from that excellent observer Dr. D. L. Phares, of Woodville, Miss.:]

"The caterpillar generally makes its first appearance at or about the same spot in a field year after year, partially or wholly denuding a few square rods or an acre or two. That is the first appearance *generally* noticed by planters. Close observers find a few earlier, and only a few leaves nibbled on only a stalk or two of cotton. In due time the moths from this first, or rather second, brood deposit their eggs in all parts of the field when the foliage is in right condition for feeding the young. In a few days more all parts of the field are stripped simultaneously, that is, so far as eaten at all. This when the destruction is early. When broods are smaller, the successive generations appear for three, five, and even seven months.

"They are not Army Worms. They usually hatch and pass through all transformations on the same plant on which the egg is deposited. If accidentally thrown off, they return to the plant when practicable. Sometimes violent storms of wind and rain sweep nearly all off and wash them up in vast heaps against fences, &c., where they putrefy. Dry, hot sunshine seems to destroy them in all stages; and sometimes, under such conditions, they abandon the partially denuded plants and move in immense masses from the field; not so often, it seems to me, for other food, as to escape the intense heat. Under such conditions one rarely ever ascends another cotton plant. Their march is to death. If a road be in the way and dusty, and still worse sandy or gravelly, few succeed in passing the barrier. The exposed hot ground kills them, and sometimes we have seen them in the road-side ditches several inches deep, infecting the air with putrefactive stench.

"Another point: If the moth deposits no eggs in any part of a field, no caterpillars will attack that part. She knows evidently where the young can subsist and where not, and she deposits her eggs accordingly. If the plant is in condition to feed the moth, I suppose it is in condition to hatch and feed the young. Little or no difference is perceptible by the common planter in the condition of the plant on two sides of a line that may divide an injured and uninjured field. A little distance from the line the difference is not perceptible. The plant is not so tender. Its chemical and mechanical condition both unfit it for the food of the caterpillar; therefore the moth deposits no eggs on it, nor will the caterpillars if placed on it eat it. This is specially and annually noticed on rolling or undulating lands, and sometimes on lands to the eye apparently level. This is my fortieth crop on the lands where I reside, and in no year has my whole crop been eaten off. The crops are often destroyed in Madison County and other points north as well as south of me before any damage is done here by the caterpillar. This depends on condition of plant."



INDEX.

A.

Abutilon, 12
Aceratodes cornutus, 36
acra, *Epilosa*, 11
 Action of moth, 29
 Activity displayed in inventing machines for poisoning worms, 54
adonides, *Dactylopius*, 10
 Advantages in using poison in powder form, 35
Agialitis vocifera, 32
 Affleck, Thomas, early writings of, on cotton insects, 2
Agrius phoeniceus, 32
Agonoderus, 35
 Alcoholic extract of Pyrethrum powder, 64
Aletia, 7, 9, 10, 11, 25, 26, 27
Aletia argillacea, 7, 9, 10, 25
Aletia affected by dryness, 21
 destroyed by storms, 21
 chrysalis of, 12
 Dipterous enemies of, 36
 egg of, 9
 fed upon by birds, 33
 fed upon by insects, 33
 first description of, 8
 Heteropterous enemies of, 36
 hibernation of, 24
 Hymenopterous enemies of, 34
 imago of, 13
 infested by Ichneumon-flies, 44
 infested by parasites, 38
 infested by Tachina-fly, 40
 invertebrate enemies of, 33
 larva of, 10
 natural enemies of, 31
 parasites of, 38
 sexual differences of, 14
 vertebrates enemies of, 33
aletia, *Tachina*, 40
Aleurodes, 10
Aleurodid, egg of, infested by *Trichogramma*, 39
 Allen Duster, the, 81
Ambrosia trifida, 67
americana, *Oblitocampa*, 45
americanus, *Coccygus*, 32
Anasa armigera, 36
 Anderson, E. H., answers to circular, 133
 experiments on hibernation, 24
 theory of origin of worms, 24, 134
Antioedactylus, 35
annulicornis, *Pimpla*, 44
annulipes, *Pimpla*, 45
Anomis, 2, 124, 125
 exata, 10
Anthracorida, 36
 Antidote for Paris green poison, 56

Ant-lions, 37
Anta, connection of, with *Aletia*, 23
 important as enemies of *Aletia*, 34
 little attracted by the glands, 34
 protection of, 34
Apatura heros, 43
 lycaon, 43
Aphelogenia furcata, 35
Aphides, 10, 34
 connection of, with *Aletia*, 23
 Apple blossoma, 15
 pomace, fed on by moth, 15
 Apples, fed on by moth, 15
 Apple Worm, 46
 Appropriation made to Department of Agriculture, 1
Apiomerus crassipes, 36.
Arachnida, 33
archippus, *Donaie*, 29, 60
argillacea, *Aletia*, 7, 9, 10, 25
armigera, *Anasa*, 36
 Heliothis, 12, 26, 101
 Army Worm, 8
 Arseniate of soda, 59, 60
 Arsenic, 57, 58
 Arsenical compounds, 55, 58
 importance of, 55
 substitutes for, 56
 poisons, writers against use of 55
 Arsenic, applied in liquid form, 59
 applied in powder form, 59
 commercial, 58, 59
 disadvantages of, 58
 patent on, 59
 price of, 59
 Arsenious acid, 59
Asilida, 36
Asilus, 37
Aspilta virescens, 25
 habits of, 25
 larva of, 25
asterias, *Papilio*, 69
 Atlanta Constitution, 15
atomaria, *Phoberia*, 27
atropes, *Galerita*, 35
atropivora, *Senometopia*, 41
Attacus cecropia, 47
 polyphemus, 47
 promethea, 46
aubletia, *Verbena*, 15
azedarach, *Melia*, 67

B.

Bag Worm, 45
 Bailey, Judge J. F., 15
Basalys, 44

- Bats devouring moths, 32
 Bee, H. P., answers to circular, 181
 Beer-mash, 68
 experiments with, 69
bellicosa, *Polistes*, 35
Belvoisia bifasciata, 41, 42
 larva of, 42
 puparium of, 42
bifasciata, *Belvoisia*, 41, 42
 Binkley Atomizer, the, 90, 91
 Lamp, the, 102
 Birds feeding upon Aletia, 32
 Blackthorn, blossoms of, 15
 Bluebird, 32
 Blue-jay, 32
 Boll Worm, 12, 13, 14, 26, 101
Bombyx, 45
Brachinus, 35
 Brushing-machines, substitute for, 54
 Brushing off the worms, 49, 50
 Buhach, 63
 Burnett, W. I., theory of immigration of moth, 28.
- C.
- Callida decora*, 35
 Canker-worms, 38, 61
Caloptenus differentialis, 39
 infested by *Sarcophaga*, 39
 Capers, C. W., letter to, by Say, 8
capitatum, *Oroton*, 67
capsularis, *Oorchorus*, 49
Carabida, 35
 Carbolic acid, 67
 effects of, on Aletia, 67
 Cardinal Grosebeak, 32
Cardinalis virginianus, 32
caritaria, *Sarcophaga*, 40
carneum, *Pyrethrum*, 62
 Carolina Mantis, 37
carolina, *Mantis*, 37
 Tetracha, 35
carolinense, *Solanum*, 67
carolinensis, *Cerasus*, 15
Carpocapsa pomonella, 46
 Case-bearing Bombycid moth, 45
Cassia occidentalis, 67
 Caterpillar, 8
 Caustic soda, 59
cecropia, *Attacus*, 47
Cerasus carolinensis, 15
cervicaria, *Saccharomyces*, 69
Chalcididae, 42, 44
Chalcis ovata, 43
 larva of, 43
 pupa of, 43
 Characters of the insect, 9
 moth, 14
Chaetognathus pensylvanicus, 35
 Chenille, 8
 Chickasaw plum, blossoms of, 15
 China tree, 67
 Chinese quince, blossoms of, 15
 Chisholm, Robert, 23
Chordetes, 33
 Chrysalis, cremaster of, 13
 distinguishing traits of, 13
- Chrysalis*, the, 12
Chrysopa, 10, 37
 eggs of, 37
 larva of, 37
Cicindela, 35
 circumpicta, 35
Cicindela, 35
cinerariaefolium, *Pyrethrum*, 62, 63
cinerea, *Stenopoda*, 36
 Circular relating to Cotton Worm, 1
circumpicta, *Cicindela*, 35
Cirrospilus, 42
 esurus, 43
Clitheronia regalis, 41
 Clarke, P. S., answers to circular, 115
 Classification of cotton belt, 3
Cliticampa americana, 45
Clivina, 35
 Cobalt, 57
Coccinellida, 10, 35
Coccygus americanus, 32
 Cocklebur, 67
 Coffee Weed, 67
 Coleopterous enemies of Aletia, 35
Collops quadrimaculatus, 35
 Commercial arsenic, 58, 59
commutata, *Ipomea*, 12
 Compounds of arsenic, 58
 Comstock, J. H., completes work done in Department of Agriculture, 2
 Concerted action in destroying the moth, 100
 poisoning worms, 54
concolorata, *Tachina*, 42
 Condition of plant connected with first appearance of worms, 18
conquisitor, *Cryptus*, 44
 Pimpla, 25, 44, 45, 46
 Contrivances for mixing poison, 74
 dusting poison, 74
 spraying, 81
 sprinkling, 81
 Convergent Ladybird, 35
 Copper, sulphate of, 59
Corchorus capsularis, 49
cornutum, *Solanum*, 67
cornutus, *Aceratodes*, 33
 Cotton belt, classification of, 3
 southern portion of, defined, 4
 Caterpillar, 8
 cultivation in Mexico, 131, 132
 insects, early writings on, 2
 Moth, 8, 9, 14
 plant eaten to the ground, 23
 seed meal, 57
 oil, 66, 67
 effects of, on worms, 66
 experiments with, 66
 Worm, 7
 circular relating to the, 1
 full-grown, 11
 losses occasioned by, 7
 newly hatched, 10
- Cow-pea, 15
crassipes, *Apionerus*, 36
 Cremaster of Aletia chrysalis, 13
crenatus, *Loxandrus*, 35

eristatus, *Oyanurus*, 32
Prionotus, 36
Oroton capitatum, 67
glandulosum, 67
lindheimerii, 67
monanthoginum, 67
texanum, 67
Oryptus conquisitor, 44
extrematis, 47
nuncius, 46, 47
plourivinctus, 44
samiae, 47
Cuckoo, 32
custator, *Thyanta*, 36
Cyanide of potassium, 59
Oyanurus eristatus, 32
Cydidae, 36
cynicus, *Podisus*, 36

D.

Dactylopius adonidum, 10
Dalmatian Insect Powder, 62
Danaus archippus, 29, 60
Datura stramonium, 67
Daughtrey Atomizer, the, 84
Davis Duster, the, 78
Dead Shot, Johnson's, 59
 Johnson's improved, 59
decandra, *Phytolacca*, 67
Decoctions of Pyrethrum powder, 63, 64
 various plants, 67
decora, *Callida*, 35
Department of Agriculture, appropriation made
 to, 1
 investigation com-
 menced under, 1
 investigation trans-
 ferred to the Commission, 1
Dermia maculata, 43
Destruction of the moth, 100
Destructiveness of worm, 7
Development of worms, wet weather favor, 20
Devouring *Cirrospilus*, 42
Dextrine, 59, 60
diadema, *Sinea*, 36
Didictyum, 44
 zigzag, 44
Digger Wasps, 35
differentialis, *Coloptenus*, 39
Diluenta, mixed with Paris green, 37
Dipterous enemies of Aletia, 36
 parasites of Aletia, 39
distinctus, *Merocoris*, 36
Distinguishing traits of chrysalis, 13
 moth, 14
Diversified agriculture, 49
Dixon, H. O., answers to circular, 126
Dodge, C. R., statistics from, 7
Dodge, J. R., statistics from, 7
Dolichonyx oryzivorus, 32
Dolichos, 15
Doryllus, 34
Dorymyrmex insanus, var. *flavus*, 34
Dragon-flies, 37, 38
 habits of, 37

Dryness, effect of, on Aletia, 21
Dryocampa, 41
Dusting the plants by hand, 74
 sifting, 74
dyaua, *Plusia*, 11

E.

Egg of Aletia, 9
eleagnifolium, *Solanum*, 67
Empusa musca, 68
English Sparrow, 33
Epeira, 33
ephemeraformis, *Thyridopteryx*, 45
Eraz, 37
erosa, *Phymata*, 36
esurus, *Cirrospilus*, 43
Euphorbia marginata, 67
Euschistus punctipes, 36
tristigmus, 36
assilis, 36
evanescens, *Trichogramma*, 39
Evangorus viridis, 36
Ewing Brushing-Machine, the, 50
exacta, *Anomis*, 10
Experiments with decoctions of various plants, 67
Extract of Pyrethrum powder, 64
Extracts from various plants, 67
extrematis, *Oryptus*, 47

F.

Facts for and against hibernation, 28, 29
False opinions dispelled, 4
Fecundity of moth, 15
femoratus, *Metapodius*, 36
Figs fed on by moth, 15
fimbriatus, *Stiretrus*, 36
Fireflies, 35
Fires for destroying the moths, 100
First description of Aletia, 8
 brood of worms, 17
 worms, condition of plant connected with
 first appearance of, 18
 few in number, 16
 time when they appear, 16
 reappear in same locality, 19
 condition of soil connected with ap-
 pearance of, 18
 theory of appearance of, 19
First generation of worms confined to spots, 23
assilis, *Euschistus*, 36
flavicauda, *Tachina*, 40
flavidus, *Sericoaderus*, 36
Flesh-fly, the common, 39
Flight of Moth, 14, 23
Flour, 67
Fountain Pump, 35
Fordtran Cotton-Moth Destroyer, 105
frugiperda, *Laphrygma*, 26
Fruits fed on by moth, 15
Full-grown Cotton Worm, 11
Fungus infection, 68
 experiments on, 69
furcata, *Aphelogenia*, 35

G.

Galerita atripes, 35

Garret Lamp, the, 102
geminata, Solenopsis, 34
 Generations, number of, 21, 22
 Genitalia of male moth, 14
germanica, Vespa, 70
 Gillespie, G. E., answers to circular, 122
 Glands upon cotton plant, 15
glandulosum, Orotan, 67
 Glover, Townsend, early writings of, on cotton insects, 2
 Glover, remarks of, on parasites of *Aletia*, 46
glycerium, Paphia, 29
 Goat Weed, 67
 Goodheart Duster and Sprinkler, the, 81
 Goodin Sprinkler, the, 85
 Gorham, Dr., 28
 describes parasite of *Aletia*, 45
Gossypium, 12
 Grace, J. W., answers to circular, 123
 Grape leaf-folder, 43
 Gray Sprinkler, the, 83
 Grass-worm, 26
 Grote, A. R., views of, as to first appearance of worms, 16
 views of, on hibernation, 28, 29
 Ground-beetles, 35, 101
 Gum arabic, 57
 tracacanth, 57

H.

Habits of *Platyhyphen scabra*, 27
 of *Aspila virescens*, 25
 of Cotton Moth, 14
 Hackberry-feeding worms, 43
 Hagen, H. A., paper of, on fungus infection, 68
 Hamilton, D. M., answers to circular, 109
Harpalus, 35
Harporhynchus rufus, 32
 Harris, Robert, letter of, 25
Harrisii, Labidus, 34
 Hatching of locusts, 17
Heliophyllum indicum, 67
Heliothis armigera, 12, 26, 101
Helluomorpha texana, 35
 laticornis, 35
 Helm Brushing-Machine, 51
Hemerobiidae, 37
heras, Apatura, 43
 Heteropterous enemies of *Aletia*, 36
 Hibernation of *Aletia*, 24, 115, 116, 117
 of moth, facts for and against, 29
 full discussion of, 24
 summary facts on, 30
 Hibernating localities, 31
 portion of cotton belt, 29
 Hickory leaves, 67
Mlaris, Rhabdigaeter, 36
 Hilgard, E. W., letter from, 63
 House-fly, fungus of, 68
 Hoyt, L. D., answers to circular, 117
 Humphreys, John T., on hibernation, 26
 Hurd Blower, the, 76, 84, 99
Hyla, 33
 Hymenopterous enemies of *Aletia*, 34
Hypena scabralis, 27

I.

Ichneumon, 47
Ichneumon-flies infesting *Aletia*, 44
Ichneumonidae, 44
 Imago, 13
indicum, Heliophyllum, 67
 Ingenuity displayed in the South, 48
 Influences of wet weather indirectly on worm, 21
insanus, Dorymyrmex, 34
 Insect Powder, Dalmatian, 62
 Persian, 62
insidiosus, Triphleps, 36
 Introductory, 1
 Introduction of English Sparrow, 33
 Inventions, most numerous in Texas, 48
 they post-date the late civil war, 48
 to destroy *Aletia*, 48
 Invertebrate enemies, 33
 Investigation, transferred to the Commission, 1
 commenced under Department of Agriculture, 1
 need and importance of the, 2
Ipomea commutata, 12
 Iske Brushing-Machine, 53

J.

Jamestown Weed, 67
 Jaeger Sprinkler, the, 88
 Johnson's Dead Shot, 59
 Improved Dead Shot, 59
 Spray Machine, 88
 Jute, recommended as protection, 49

K.

Kearney Chemical Works, 60
Kerosene, 65, 97, 102
 use of in connection with brushing-machines, 54.
 used in pans, 66
 vapor of, 97
Kerosene oil, effects of, on plants, 65
 effects of, on worms, 66
 mixed with ashes, 66
 mixed with ashes, patent on, 66
 soap made from, 66
 Killdeer plover, 32

L.

Labidus Harrisii, 34
 Melchioreri, 34
 Lace-wings, 10, 37
 eggs of, 37
Lachnosterna, 101
 Lady-birds, 10, 35
laeus, Solenophorus, 35
lava, Paspalum, 15
 Lamp made by Charles Lewis, 103
 Lamp, simple form of, 104
 Lamps, experiments with, 101
 in motion, 105
 for attracting the moth, 100
 stationary, 102
 used on large scale, 101
Lampyridae, 35
Lophria, 37
Lophrygma frugiperda, 26

Lard, 97
 Larva of *Aspila virescens*, 25
 of *Platyhyphen scabra*, 27
 the, 10
 Late planting suggested by Dr. Phares, 49
laticornis, *Helluomorpha*, 35
 Leaf-cutting ant, 34
Lebia, 35
 Le Blank Cotton-Moth Destroyer, 105
 Lee, R. A., answers to circular, 112
Leucania unipuncta, 27
 Levy Duster, the, 79
Libellulida, 37
Libellula trimaculata, 38
 Licorice root, 57
 Lime, 57
lintheimeri, *Oroton*, 67
 Little's contrivance for mixing poison, 74
 Localities where first worms appear, 19
Locusta, hatching of, 17
 Lodi Chemical Works, 59
 London Purple, 60
 advantages of, 61, 62
 analysis of, 60
 experiments with, 60
 manufacture of, 60
 price of, 62
 superior to Paris green, 62
 used in liquid suspension, 61
 used in powder form, 61
 Looses occasioned by Cotton Worm, 7
Lozandrus lucens, 35
 crenatus, 35
Loxopeza, 35
lucens, *Lozandrus*, 35
 Lupton, J. L., experiments in attracting moth, 108
lycaon, *Apatura*, 43
 Lyon's Magnetic Insect Powder, 63

M.

Machines for applying vapors, 97
 brushing off worms, 50
 powdering poisons, 74
 sprinkling and spraying, 81
maculalis, *Desmia*, 43
 Male genitalia of Cotton Moth, 14
Mantis carolina, 37
marginata, *Euphorbia*, 67
 May-beetles, 101
 McMeekin, F. M., answers to circular, 130
 McQueen Lamp, the, 103
 Mealy bug, 10
 Means of coping with the insect, 47
 Mechanical means of killing worms, 49
Melanolestes picipes, 36
 Melcher Sprinkler, the, 88
Melia azedarach, 67
 Melons injured by moth, 15, 108
Melaleimeri, *Labidus*, 34
Meroocoris distinctus, 36
Melapodius femoratus, 36
mexicana, *Oecodoma*, 34
 Middlings, 57
 Migration of moth, 26
 Migrating habit of moth, development of, 23

Milberti, *Proctacanthus*, 36, 37
Minus polyglottus, 32
 Mineral paint, 57
minuta, *Trichogramma*, 39
 Mixing the poison, 74
 Mocking-bird, 32
 Mock orange, blossoms of, 15
 Molasses, 102
 Mold, 68
 Molts of worm, 11
monanthoginum, *Oroton*, 67
 Morning-glory, 12
 Moth, attracted to sweets, 15, 106
 attracted by lights, 100
 attracted to white rags, 108
 characters of, 13
 distinguishing traits of, 14
 fecundity of, 15
 feeding on apple pomace, 15
 on peaches, 15, 106
 on persimmons, 15
 on apples, 15
 on figs, 15, 106
 on fruits, 15
 flight of, 14, 23
 habits of, 14
 injuring melons, 15
 migration of, 23
 natural food of, 15
 or Imago, 18
 sexual differences of, 14
 theory of annual immigration of, 28
 tongue of, 15
 Moths, few hibernate, 31
musca, *Empusa*, 68
 Mosquito-hawks, 37, 38

N.

Nature of bulletin, 3
 Natural enemies of Aletia, 31
 of Cotton Worm, 101
 protection of, 49
 food of moth, 15
 Need and importance of the investigation, 2
 Neuropterous enemies of Aletia, 37
 Newly-hatched Cotton Worm, 10
Nezara pennsylvanica, 36
 Night-hawk, 33
Noctua xyliua, 8
 Northern Army Worm, 17, 27
 Number of annual generations of worm, 21
 first worms, 17
nunciu, *Cryptus*, 46, 47

O.

occidentalis, *Cassia*, 67
Oebalus pugnax, 36
Oecodoma mexicana, 34
Ophiura, 8
 Opossum, 32
 Orthopterous enemies of Aletia, 37
ovata, *Chalcis*, 43
 Ovale Chalcis, the, 43
oryzovor, *Dolychopus*, 32
Oxyopes viridans, 33

P.

- Paint, 102
 Paper-wasps, 35
Paphia glycerium, 29
Papilio asterias, 69
 Parasite of *Aletia*, 38
 described by Dr. Gorham, 45
 remarks on, by Glover, 46
 summary of, 47
 infesting the egg, 38
 and issuing from the worm, 39
 issuing from chrysalis, 42
 Parent of Boll Worm, 14
 Paris Green, 56, 59
 advantages of, 56
 antidote against, 56
 cost of dry application of, 57
 cost of liquid application of, 57
 disadvantages of, 56
 effect of, upon plant and soil, 56
 first introduction of, 56
 nature of, 56
 patent mixtures of, 58
 patents for, 57
 price of, in 1879, 57
 test of purity of, 56
 used in liquid suspension, 56
 used in powder form, 57
Paspalum laves, 15
 Patents for machines for dusting, 75
 Paris-green mixtures, 57
 Patent for Texas Cotton-Worm Destroyer, 60
 Peach, blossoms of, 15
 Peaches fed on by moth, 15
 Peck's Spray Machine, 84
pensylvanica, *Nezara*, 36
pensylvanicus, *Ohaulognathus*, 35
Pentarthron, 39
Pentarthrum, 39
 Perl Vapor-Generator, the, 90
 Perry, O. H., answers to circular, 128
 Persian Insect Powder, 62
 Persimmons fed on by moth, 15
 Pest poison, 60
Phalangium, 33
 Phares, D. L., on variation in date of first appearance, 16
 on the habits of the worm, 135
 appearance of worm at remote points from where cotton was previously grown, 23
 Phares, D. L., early writings of, on cotton insects, 2
phoeniceus, *Agelæus*, 32
Phoberia atomaria, 27
Phymata erosa, 36
Phytolacca, 12
picipes, *Melanolestes*, 36
Pieris rapæ, 69
Pimpla, 45
 annulipes, 46
 conquisitor, 25, 44, 45, 46
 larva of, 43, 45
 pupa of, 45
Pimplaria, 44
 Plaster, 57
Platyhypona scabra, 27

- Platyhypona scabra*, habits of, 27
 larva of, 27
Platynus, 35
pleurivinctus, *Cryptus*, 44
Plusia dyauis, 11
Podius cynicus, 36
 spinosus, 36
 Poisoned sweets and fluids for destroying the moth, 106
 Poisoning the worms, 54
 Poisons in powder form, their advantage, 55
 reasons for increase of price of, 55
 Poke Weed, 12, 67
Polistes, 35
 bellicosus, 35
 rubiginosus, 34, 35
polyglottus, *Mimus*, 32
polyphemus, *Attacus*, 47
pomonella, *Carpocapsa*, 46
 Poplar leaves, 67
 Popular names, 8
 Potassium, cyanide of, 59
 Potato-pest poison, 59
 Prairie chickens, 32
 Predaceous insects as enemies of *Aletia*, 33
pretiosa, *Trichogramma*, 39
 Prevention of injury, 48
 Principles governing use of poisons, 55
Prionotus cristatus, 36
Proctacanthus Milberti, 36, 37
Proctotrupida, 44
Promachus, 37
promethea, *Attacus*, 46
 Protection of natural enemies, 49
Prozys punctulatus, 36
Pterostichus Sayi, 35
 Pugh Lamp, the, 104
pugnax, *Oedalus*, 36
punctipes, *Euschistus*, 30
punctulatus, *Prozys*, 36
Phytolacca decandra, 67
Pyrethrum, 62
 carneum, 62
 cinerariæfolium, 62, 63
 roseum, 62
 Pyrothrum cultivated in California, 63
 essence of, 64
 powder, 62
 alcoholic extract of, 64
 cost of using of, 65
 decoction of, 63, 64
 effect of, on insects, 63
 experiments with, 62, 64
 mixed with flour, 64
 nature of, 63
 substitute for arsenical poisons, 65
 tea of, 63
 Q.

- quadrimaculatus*, *Collops*, 36
 Quail, 32
 Questions to be answered, 1, 2

R.

- Raccoon, 32
 Rain Crow, 32

Ramsay Sprinkler, the, 82
rapa, *Pieris*, 69
 Reappearance of worms in same locality, 19
 Red-wing blackbird, 32
Redutiida, 36
regalis, *Oitheronia*, 41
 Remedica, 47
Roptia taurus, 36
Rhaphigaster hilaria, 36
 Rice bird, 32
 Rigel Lamp, the, 103
 Ring-legged Pimpla, the, 46
 Robinson Dusting and Sprinkling Machine, 77, 83
 Rocky Mountain Locust infested by *Sarcophaga*, 39
roscum, *Pyrethrum*, 62
 Rosin, mixed with poisons, 57
 Rotation of crops, 49
rubiginosa, *Polistes*, 84, 35
rufus, *Haporthynchus*, 32
 Ruggles Sprinkler, the, 82
 Ruhmann Sprinkler, the, 87
 Improved Sprinkler, the, 191
 S.
Saccharomyces cerevisia, 68
 Salts of tartar, 59
samia, *Oryctus*, 47
Saprolegnia, 68
Sarcophaga, 40, 41, 42
 canaria, 40
 infesting locusts, 39
 larva of, 41
 sarracenia, 39, 41
 sarracenia, larva of, 41
 sarracenia, puparium of, 41
Sarracenia variolaris, 39
Sarracenia, *Sarcophaga*, 39, 41
Say, *Pterostichus*, 35
scabrata, *Hyppa*, 27
scabra, *Platyhyppa*, 27
 Schanck Sprinkler, the, 84
 Schler Atomizer, the, 93
 Schwarz, E. A., 17, 18, 27
 Scientific American, 8, 15
 Screw Worm, 67
Scutellerida, 36
Seymus, 35
Selenophorus laesus, 35
Senemotopia atropivora, 41
Sericoderus flavidus, 36
Sesbania vesicaria, 67
 Severe rains destructive to Cotton Worms, 20
 Sexual differences of Cotton Moth, 14
 Shelds, F. S., answers to circular, 119
Stalis stalis, 32
stalis, *Stalis*, 33
stiegling, *Solanum*, 25
 Sieves for dusting the plants, 74
Sinea diadema, 36
 Skunk, 32
 Slippery Elm, 57
 Small fields often exempt, 48
 Smell of worm, 12
 Smith, E. A., experiments of, on fungus infection, 69
 Soap-suds, 102

Soda, arseniate of, 59
 Soda, caustic, 59
 Soil, condition of, connected with first appearance of worms, 18
Solanum, 67
 carolinense, 67
 cornutum, 67
 eleagnifolium, 67
 stiegling, 25
 Soldier-beetles, 35
Solenopsis geminata, 84
 Southern Agriculturist, first description of Cotton Moth in, 8
 portion of cotton belt, 29
 Southern portion of cotton belt defined, 4
Spilosoma aerea, 11
spinosa, *Podius*, 36
 Stages of the insect, 9
 Starch, 59
 Statistics of losses, 7
 Steinmann vaporizer, the, 97
Stenopoda cinerea, 36
Stiretrus ambriatus, var. *diana*, 36
 Storms, destructive to Aletia, 21
stramonium, *Datura*, 67
strumarium, *Xanthium*, 67
 Sulphate of copper, 59
 Sulphur used for killing worms, 67
 vapor of, 99
 Sweet exudation, 15
 Sweets from grass, 15
 moth attracted to, 15
 T.
Tachina, 40, 41
 aletia, 40
 concinata, 42
 flavicauda, 40
 villiosa, 41
 Tachin-fly infesting Aletia, 40
 Tachinid larva, 41
 puparium, 41, 42
 Tar, 102
 Tartar, salts of, 59
taurus, *Roptia*, 36
 Tayler Dusting and Sprinkling Machine, 80, 82
Telephoridae, 35
Tetracha carolina, 35
 virginica, 35
Tetrastichus, 43
tezana, *Heluomorpha*, 35
tezanum, *Oroton*, 67
 Texas Cotton-Worm Destroyer, 60
 patent for, 60
 Theory of annual immigration of moth, 28
 appearance of first worms, 19
 Thrush, 32
Thyanta custator, 36
Thyridopteryx ephemeraformis, 45
 Tiger-beetles, 35, 101
 Time elapsing from one generation to another, 16
 of year when first worms appear, 16
 Tobacco, 67
 Tongue of moth, 15
 Topping cotton, 49
 Torches, 100

- Torch-lights, 103
 Townsend Sprinkler, 83
 Trichogramma Egg-parasite, the, 38
Trichogramma, 38
 evanescens, 39
 infesting egg of Aleurodid, 39
 minuta, 39
 pretiosa, description of, 39
trifida, *Ambrosia*, 67
 Tree-frog, 33
trimaoulata, *Libellula*, 38
Triphleps insidiosus, 36
tristigmus, *Euschistus*, 36
 Turkeys feeding upon the worms, 32
 Two-winged flies infesting and issuing from the worm, 39

 U.
unipuncta, *Leucania*, 27

 V.
 Vapors for destroying worms, 97
variolaris, *Sarracenia*, 39
Verbena aubletia, 15
vesicaria, *Sesbania*, 67
 Vertebrate enemies, 32
Vespa germanica, 70
villica, *Tachina*, 41
virginianus, *Cardinalis*, 32
virginica, *Tetracha*, 35
virescens, *Aspila*, 25
viridis, *Evangorus*, 36
viridans, *Oxyopes*, 33
vocifera, *Aegialitis*, 32

 W.
 Walker Lamp, the, 103
 Warner Saddle Sprinkler, the, 90
 Watchful Pimpla, the 44

 Wet weather, indirect influences of, 21
 favors development of worms, 20, 116
 Wheat flour, 57
 Wild hemp, 67
 Willie Duster, the, 75
 Sprinkler, the, 84
 Willet, J. E., experiment of, on fungus infection, 69
 Winfree, Phillip, 12
 Wolkom, J. M., answers to circular, 113
 Worm, destructiveness of, 7
 or larva, the, 10
 molts of, 11
 must hatch from egg, 9
 wet weather favors development of, 20
 smell of, 12
 pale and dark specimens of, 11
 infested by parasites, 39
 Worms, severe rains destructive to, 20
 first breed of, 17
 first "crop" of, 17
 feed only on cotton, 12
 picked off by hand, 100
 Wood-Smith Brushing-Machine, 52
 Writers against use of arsenical poisons, 55

 X.
Xanthium strumarium, 67
xylina, *Noctua*, 8.

 Y.
 Yeager Sprinkler, the, 86
 Yeast, experiments with, by Willet, 70
 ferment, paper on, by Dr. H. A. Hagen, 63
 Yellow-tailed Tachina-flies, 40
 Yoakum, F. L., answers to circular, 127
 Young Duster, the, 81

 Z.
zigzag, *Didictyum*, 44

EXPLANATION OF PLATE I.

A healthy stalk of wheat on the left, the one on the right dwarfed and the lower leaves beginning to wither and turn yellow; the stem swollen at three places, near the ground where the flaxseed (*h*) are situated, between the stem and sheathing base of the leaf.

a, egg of the Hessian Fly (greatly enlarged, as are all the figures except *e* and *h*).

b, the larva, enlarged, the line by the side, in this and other figures, showing the natural length.

c, the flaxseed, puparium or pupa case.

d, the pupa or chrysalis.

e, the Hessian Fly, natural size, laying its eggs in the creases of the leaf.

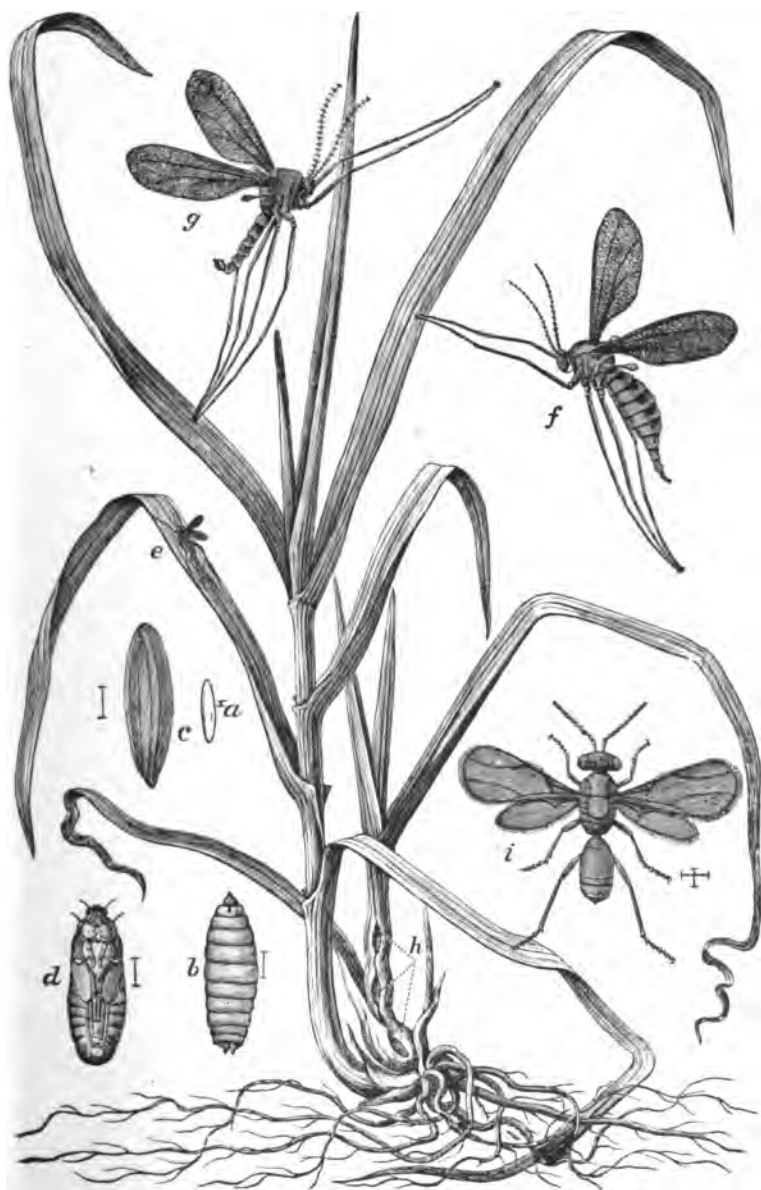
f, female Hessian Fly, much enlarged.

g, male Hessian Fly, much enlarged.

h, flaxseed between the leaves and stalk.

i, Chalcid orichneumon parasite of the Hessian Fly, male, enlarged.

Figs. *b*, drawn by Mr. Riley; *d* and *f*, by Mr. Burgess; *a*, *g*, and *c*, *i*, by the author; drawn on wood by L. Trouvelot.



THE HESSIAN FLY AND ITS TRANSFORMATIONS.

EXPLANATION OF PLATE II.

Fig. A. Side view of the female Hessian Fly, greatly enlarged.

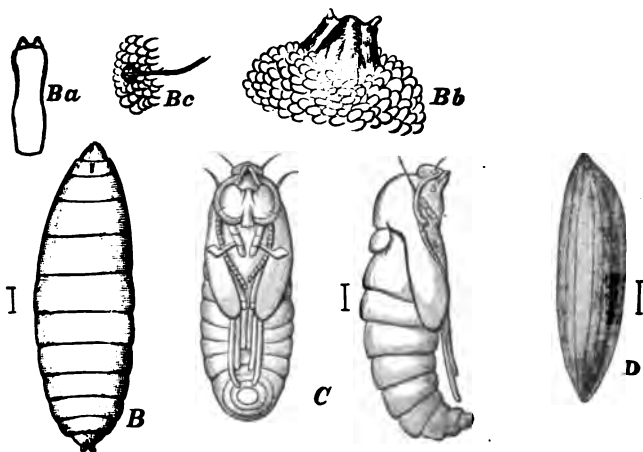
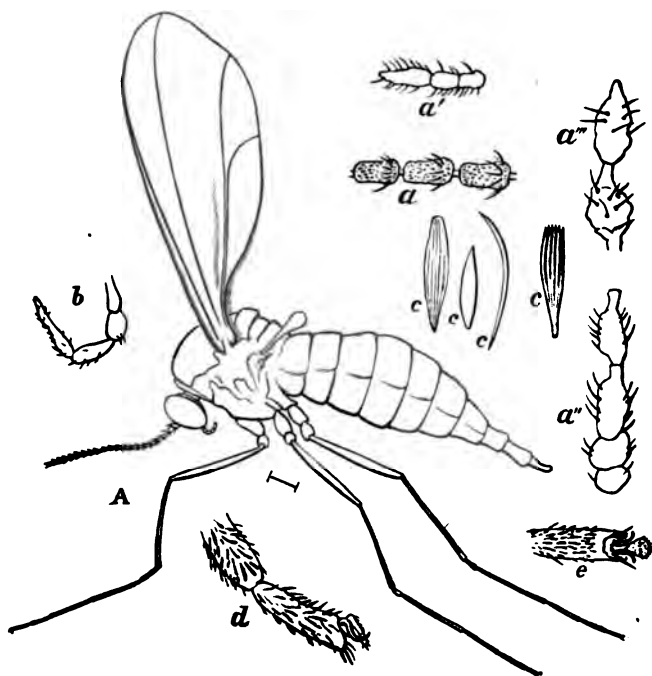
a, three joints taken from the middle of the antennæ of the female; *a'*, the three terminal female antennal joints; *a''*, the four basal, and *a'''*, the two terminal male antennal joints; *b*, a maxillary palpus; *c*, scales from the body and wings; *d*, *e*, side and vertical view of the last joint of the foot, showing the claws and foot-pad or pulvillus between them, and the scales on the joint. Drawn by Mr. E. Burgess.

Fig. B. Larva magnified, with the breast-bone in the 2d ring next to the head.

Ba, the breast-bone highly magnified; *Bb*, head from beneath, enlarged; *Bc*, larval spiracle and its tubercle and trachea leading from the spiracle. *B*, drawn by Mr. Riley; *Ba*, *b*, *c*, by Mr. Burgess.

Fig. C. Side and front view of the pupa or chrysalis. Drawn by Mr. Burgess. The abdomen of the side view of pupa is rather long, as the insect, when drawn, was just emerging from the semi-pupa stage, which it assumed December 1st.

Fig. D. The flaxseed, puparium, or pupa case. The line by the side of the complete figures denotes the natural length of the insect.



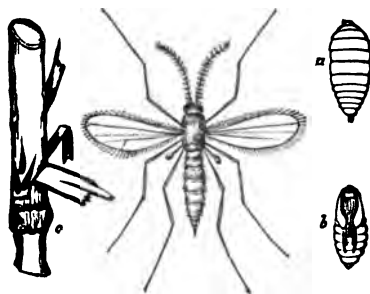
TRANSFORMATIONS OF THE HESSIAN FLY.

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 4.

THE HESSIAN FLY,

ITS RAVAGES, HABITS, ENEMIES, AND MEANS OF
PREVENTING ITS INCREASE.



By A. S. PACKARD, Jr., M. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1880.

MEMBERS OF THE COMMISSION.

CHARLES V. RILEY, *Chief*,
Washington, D. C.

A. S. PACKARD, JR., *Secretary*,
Providence, R. I.

CYRUS THOMAS, *Disbursing Agent*,
Carbondale, Ill.

THE HESSIAN FLY:

ITS RAVAGES, HABITS, AND MEANS OF PREVENTING ITS INCREASE.

INTRODUCTION.

Next to the Rocky Mountain Locust, the Cotton Worm, and Chinch Bug, the Hessian Fly is at present the most destructive of our noxious insects. It attacks wheat, our most important agricultural product, and at times has been so abundant as to cause farmers to abandon the culture of this grain over large sections of the Union. While the fly has been well known and destructive for about a century, the vast extension within a decade of years of the wheat-growing area of the West, and the corresponding prevalence of the fly in the Northwestern States, together with its wide-spread destructiveness, has given fresh interest and importance to this pest. Moreover, the cultivation of wheat in the New England States, where about twenty years ago it was abandoned on account of the ravages of this fly and the wheat midge, has been resumed in part, so that the dissemination over the wheat area of the United States of the known facts in regard to its habits and modes of doing injury seems necessary. This area, as seen in part by the map* appended to this Bulletin, which has been compiled from Walker's Statistical Atlas, embraces all of the United States north of the 35th parallel of latitude and east of the 93d meridian, with the addition of tracts in Dakota, Montana, Colorado, New Mexico, and Utah, as well as in California, Oregon, and Washington Territory. These last-named wheat areas were not mapped by General Walker, and have been omitted on the present map, since the Hessian Fly is not known to exist west of Eastern Kansas.

Though the habits of the Hessian Fly are tolerably well known, much additional knowledge is desirable regarding its distribution, its breeding habits, and its parasites, while in order to properly apply the best preventive remedies, to stamp out the pest as it appears in new wheat sections, we need the results of a larger number of experiments as to the effects of early and late sowing, what varieties of wheat to sow, and as to the value of manures and artificial fertilizers in promoting the rapid and healthy growth of the young wheat, by which it may outgrow the weakening effects of the worm and ripen its grain.

The object of this Bulletin is not so much to convey new information to wheat-growers as to briefly state what thus far is known as to the appearance, ravages, habits, and remedies against its attacks. By widely disseminating this knowledge, seeking fresh facts from practical farmers all over the country, who are hereby asked to send to the author all new facts and results of valuable experiments, it is hoped and believed that

* Taken from a report on the Rocky Mountain Locust and other insects now injuring, or likely to injure, field and garden crops in the Western States and Territories. By A. S. Packard, Jr. From the Report for 1875 of Hayden's United States Geological Survey of the Territories.

the Commission will be able in a future report, after another season's work in the field, to throw further light on the subject.

Although this pamphlet has been prepared by but one member of the Commission, the writer is indebted to Prof. C. V. Riley for drawings, specimens, and data; to Professor Thomas for facts and suggestions; and would also acknowledge aid received from Prof. A. J. Cook, of the State Agricultural College, Lansing, Mich., whose address on the Hessian Fly has been of much service and liberally quoted in this Bulletin, and also from the correspondents and agricultural papers mentioned here and there in the following pages.

LOSSES OCCASIONED BY THE HESSIAN FLY.

This fly first became a serious pest in the country in the year 1779, although, as will be seen further on in the section on the distribution of the insect, it probably began its work of destruction on Staten Island and Long Island in 1776. According to Fitch, 1779 was probably the date when its ravages actually began. "The crops of wheat were severely injured or wholly destroyed by it in King and Richmond Counties during several of the following years, and each succeeding generation regularly enlarged the sphere of its devastations in every direction."

In 1781 the fly almost totally destroyed the wheat crop in Eastern Long Island, and in 1786 the crops were either totally or partially destroyed in New Jersey in and about Prospect, an area situated forty miles southwest of Staten Island. In 1786 and 1787 the ravages of this pest attracted much attention in New York and Pennsylvania; the wheat crop on Eastern Long Island having been "cut off almost universally." About Trenton, N. J., in 1788, the wheat crop was in many cases a total failure. As wheat in large quantities was at this period exported to Great Britain, "accounts of the appalling havoc that this insect was making excited the attention of the government there and aroused their fears lest so dreadful a scourge should be introduced into that country by means of the American grain." (Fitch.) As a result, the exportation of grain from America was prohibited until the English Government was assured that the fly with eggs could not be introduced in the grain. As long since as 1800, Dr. S. L. Mitchell, of New York, affirmed that "the insect is more formidable to us than would be an army of twenty thousand Hessians." (Herrick.)

Between 1789 and 1803 severe losses ensued from its attacks in Saratoga and Washington Counties, New York; "on two or three occasions many of the fields in Saratoga were entirely destroyed."

In 1804 President Dwight, of Yale College, remarked that "this insect is feeble and helpless in the extreme, defenseless against the least enemy, and crushed by the most delicate touch; yet for many years it has taxed this country annually more, perhaps, than a million of dollars." (Herrick.)

In 1803 and 1804, in the neighborhood of Richmond, Va., "they swept whole fields." In 1817 it "renewed its ravages in various sections of

the country; was unusually abundant," and "in parts of Maryland and Virginia it was perhaps more destructive than it had ever been before."

At what year the Hessian Fly first occurred in the New England States is uncertain; so far as we can ascertain it was first noticed at New Haven, Conn., in 1833, by Mr. Herrick, a careful entomologist, but without doubt it was introduced from New York early in the century.

In Lower Canada it was, according to Hind,* between 1805 and 1816, "prevalent and destructive in some parts," but in 1830-'36 it disappeared in Lower Canada.

The fly first appeared in 1837 at Paw Paw, Mich., in the second crop sown in Van Buren County; none had been raised at a point nearer than twelve miles. (D. Woodman.)

The Hessian Fly has been known in Person County, North Carolina, for fifty years; and another correspondent writes us from Goldsborough, N. C., that—

Previous to the period, say 1840, our farmers had been accustomed to sow wheat as early as September, but a fly, called by them the "Hessian Fly," so depredated that they deferred sowing to the latter part of November, and now, generally, to "between the Christmases" (new and old Christmas); their crop is now unmolested by the Hessian or any other fly.

The losses in Pennsylvania in 1842 were heavy, the wheat crop of the State being estimated at 20 per cent. less than in the preceding year, the fly being the principal cause of the loss. At this year Ohio was visited by it, when "it appeared to be increasing so much that serious apprehensions were beginning to be felt respecting its future ravages." (Fitch.)

Great havoc in many fields in Maryland and Virginia was committed by it in 1843. In the following year it did much injury in Northern Indiana and Illinois and the contiguous parts of Michigan and Wisconsin, in many places occasioning "almost a total failure of the crops." In Michigan the wheat crop was almost an entire failure. On Long Island, at Rochester, N. Y., and throughout Pennsylvania the losses this year were severe; the following year it did more or less injury all over the State of Illinois, while in the central parts of Maryland the crops, in many instances, were rendered totally worthless. "In Georgia, moreover, its ravages in the counties around Milledgeville are said to have been dreadful; whole fields were totally destroyed, and others yielded not more than a fourth of an ordinary crop."

In 1846, in the upper counties of Georgia, it was said "the fly has committed such ravages upon the wheat as scarcely to leave enough seed for another year." Throughout the State of New York it was destructive this year; in the western section the loss from this insect was estimated at not less than 500,000 bushels. In Maryland this same year (1846), as recorded by Fitch, "so great ravages have not been committed by the Hessian Fly since 1817. On some of the best land wheat has

*Essay on Insects and Diseases injurious to the Wheat Crops, by H. Y. Hind, Toronto, Canada, 1857, 8°, p. 133.

been plowed up, and other portions are so much injured that they will not be worth harvesting. At least one-half of the crop of Talbot County has been destroyed." And in the upper counties of Georgia it is said "the fly has committed such ravages upon the wheat as scarcely to leave enough seed for another year."

In 1847 the losses were generally widespread but light, while in 1849 it was destructive in some of the counties in New York, and especially in Ohio. From this date until 1853 it was not destructive, but this year it "committed great ravages in some parts of Pennsylvania." In 1854 it was destructive in Aroostook County, Maine, as well as in Michigan.

From 1855 to 1860 the Hessian Fly attracted little attention from the agricultural community. In 1860 the fly "had reached as far west as Iowa and Minnesota, and in 1863 the wheat-fields along the Detroit and Milwaukee Railroad promised nothing because of the ravages of this pest." (Professor Cook).^{*} In 1866 it is reported to have occurred in Maryland, Delaware, and Ohio, and in 1868, according to a writer in the *American Entomologist*, about Fond du Lac, Wis., "much of the wheat crop was damaged by it."

In 1871 it was generally prevalent throughout the Middle States from South and North Carolina and Virginia to Missouri northward; also occurring in Kansas, Georgia, and Minnesota, and in 1872 and 1873 was destructive and widespread in Maryland, Ohio, Indiana, Illinois, and Eastern as well as Western Virginia, as well as in Michigan, "as also in the States south and west" of the last-named commonwealth.

In 1874 it was widespread, but much less destructive; in 1875 and 1876 it was especially destructive in Missouri, Pennsylvania, and Virginia. In 1876 "it appeared in force in many of the southern counties of Michigan, reaching as far north as Mason, in Ingham County, causing much destruction." (Professor Cook.)

In 1877 the losses again became heavy over a large part of the wheat area. At Lawrence, Kans., the early-sown wheat "suffered a good deal from the ravages of the Hessian Fly." At Gardner, Kans., all early-sown wheat "was full" of the "flaxseed" of the Hessian Fly. At Saint Genevieve, Mo., the fly was "much worse than for years past." At Independence, Mo., the crop in some fields was nearly a failure. In Henderson County, Kentucky, while prevalent, only one wheat-field was "badly damaged"; while in Vanderburgh County, Indiana, "many fields were infected." In Central Illinois a correspondent of the *Cultivator and Country Gentleman* states that "the Hessian Fly has been present in the lower portion of the winter-wheat region for several years," and in 1877 "it appears that the Hessian Fly is generally present in greater or less numbers over the whole winter-wheat region; that in almost every case it has attacked and done more or less damage to early-sown wheat-fields."

^{*} In his seventh report, written apparently in 1862, Dr. Fitch remarks: "We hear of it at the present time as very destructive in Illinois and some of the contiguous States, the crop in many wheat-fields being totally ruined by it."

In Michigan the fly, while troublesome in 1876 was also very generally so in the succeeding year, as stated by Professor Cook, as follows:

This year, 1877, we hear of it as more broadly distributed in our State, while complaints come to our ears from Ohio, Indiana, Illinois, New York, and Pennsylvania. Since writing the above, I have passed through our State and also the State of Ohio, on two of the different trunk lines of railroads, and I find that all through Southern Michigan and all of Ohio, at least north of the latitude of Columbus and Dayton, this insect abounds in force.*

The following extracts from Michigan papers show the situation in that State this year:

Farmers are complaining of the ravages of the "fly" in their wheat-fields. Much damage is reported.—*Jonesville Independent*.

Mr. James Taylor showed some wheat-stalks from his farm to-day which had over forty insects in one stalk.—*Kalamazoo Gazette*.

Wheat heading out ten days to two weeks earlier than usual this year, and doubtless much of it will be ready to cut in June.—*Portland Observer*.

The "fly" or "insect," as called by the farmers, is playing sad havoc with the wheat crop in this county. Not over half a crop will be realized.—*Kalamazoo Gazette*.

The fly is very seriously injuring the wheat in Porter. One of the largest farmers in that township yesterday told us that a few weeks ago he would not have taken 3,000 bushels for his crop, but now he would gladly take 1,000.—*Paw Paw Courier*.

Much complaint is now heard from all sides in regard to the work of the insects in early-sown wheat. The dry weather has so far retarded the growth as to give the pests the power to destroy. There is little question that early-sown wheat is suffering greatly.—*Marshall Expounder*.

Farmers from all over the county come to town looking doleful enough. The wheat crop promises to be almost a total failure. Two weeks ago everybody was happy over the prospects of an abundant harvest, but now flies, worms, and drought seem to have ruined the crop and blighted every home.—*Marshall Statesman*.

Farmers from all the adjoining towns complain that their growing wheat crops are badly injured by the insects. Wheat-fields which promised a heavy yield two weeks ago, it is thought, will not produce over a half a crop, and many fields are reported as already nearly destroyed. Naturally some allowance should be made for the apprehensions of those whose fields are thus ravaged; but there is no doubt that the crop through this section is materially damaged by these destructive pests.—*Battle Creek Journal*.

Mr. T. F. Miller, of Richland, brought into our office Monday morning a handful of wheat (taken from a farm on the prairie) that is literally alive with the insect. He says that in his opinion nearly every field in Richland is so badly affected that there cannot be half or even a third of a crop. The dry weather has stopped the growth, and the wheat is more affected on that account. We hear the same report from other parts of the county. Grain is also suffering for want of rain.—*Kalamazoo Gazette*.

The following extract from the *New York Cultivator and Country Gentleman* will give the condition of affairs in West Virginia:

Since reading your article making known Mr. A. S. Packard's request, in the issue of November 15, I have had occasion to make a business trip through Hardy, Hampshire, Mineral, and Grant Counties, and find upon examination that there is not a single field which is not more or less damaged by the fly. The early-sown wheat, having luxuriant growth, does not seem to be entirely destroyed, but has the appearance of mixed yellow and green. I find, upon close examination, it is filled with the fly. Other fields, sown after corn-cutting, show a greater amount of damage; one in particular, a limestone upland, was scarcely tinted with green, the fly having already

* The Hessian Fly. A lecture by Prof. A. J. Cook, of the Michigan State Agricultural College, delivered at Farmer's Institute held at Paw Paw and Climax, Mich., 1878, 8vo., p. 14.

consumed nearly the whole of it. My course from this point was north and west. I find that the farther north I travel the more damaged is the wheat. In this (Hardy) county the damage, so far, appears not to be material. Some crops of early-sown wheat were considerably shortened last year, the first year in many that we have felt the effects of the fly. One farmer, whose wheat seemed already a failure, asked me what he should do. I advised when the land was dry, or hard frozen, to put all the sheep he could get upon it, and keep them there until they had eaten it off as close as a sheep could nip, as the only remedy. I thought that the sheep could do no worse than what must be eventually done by the fly, and it might save the crop. He asked me if I thought the insect would be "wholesome for the sheep." This I could not answer, and refer the query to you.—R. M. W., Moorefield, W. Va.

A correspondent of the same paper thus records the injury done by this insect about Syracuse, N. Y.:

Wheat sown early, from the 1st to the 20th of September, has made an extraordinary growth. The fine weather was favorable; besides more care has been paid to good culture than before. The seed also has been selected, cleaned, and graded with greater care, showing much progress. From appearances now, it will result in a loss. Whole fields, and parts of others, are turning yellow, showing the ravages of the fly to a larger extent than I ever before witnessed. It begun to turn yellow on knolls, or where the plaster rock came near the surface, and was thought only the effect of dry weather, but now it has extended all over early-sowed fields. Should the warm weather continue, great injury will result to the entire crop, as it has been sown much earlier than usual and has looked remarkably fair. Later sowing, with a greater breadth of spring wheat, is the only remedy now offered. Will other parties in different sections make an examination and send notes?—C., Syracuse, N. Y.

While, so far as we have been able to learn, no serious damage, if any, has been done to wheat in New England by this pest since 1854, in Western Canada it again became abundant in 1874, but most injurious in 1876 and 1877. In 1876 it appeared in great force in the townships of Amabel, North Bruce, Grey, and Kippel.

In 1878, the losses were still heavy in Southern and Central Michigan, but in 1879 the insect seemed to be moving northward, the greatest amount of injury being sustained in the northern part of the State, the fly being scarce in the middle of the State.

As regards its abundance in southeastern Michigan in 1878 and 1879, Mr. F. S. Sleeper, of Galesburg, near Kalamazoo, writes me as follows:

In February, 1878, I noticed what was to me something new. The month was very warm and spring-like. For nearly three weeks the temperature did not reach the freezing point. About the middle of the month I noticed many flies flying over the wheat and depositing their eggs, but, so far as I could see, none reached the "flax-seed" state. I have several times noticed the fly depositing her eggs as late in the autumn as October 26.

Since the summer of 1877 no very serious damage was done until last spring (1879). Then the fly put in an appearance. On the 26th of May, above one field of wheat the air was almost black with them. I never saw such a sight before. I had fears that the fall-sown wheat would be badly damaged, but it is not so, as none but early-sown wheat is damaged in the least. I presume it is owing to the fact that September was cold, so that probably the sudden atmospheric changes destroyed all that had not reached the pupa state.

In 1878 it did great damage in Dickson County, Tennessee. In Maryland, the winter wheat in the neighborhood of Baltimore, Md., was, in 1879 and the spring of 1880, seriously affected. In Central New York,

in Seneca and Tompkins counties, considerable damage was done in 1878 and 1879. About Watertown, N. Y., some injury was done in 1879, one field of wheat being ruined.

In 1879 apprehensions that injury would be caused by the fly were felt in Lowell, N. C.

These facts indicate that the losses from the Hessian Fly are greatest in the grain-raising areas of the middle and northwestern States, and adjoining regions of Canada, and that the New England States have been comparatively free from their attacks, though this is perhaps mainly due to the fact that so little wheat is cultivated there. No statistics as to the losses have ever been collected, either by the State or national governments, but they have been sufficient to occasion much consternation and alarm at certain years. By reference to the chapter on the supposed periodicity in its attacks or years of maximum abundance, the reader may learn approximately by the history of the past how often its more serious attacks may be probably renewed.

DESCRIPTION OF THE HESSIAN FLY.

This insect belongs to the Diptera or two-winged insects, of which the common house fly is the best-known type. It belongs to the family *Cecidomyiidae*, a large group of minute flies, resembling the crane flies or daddy-long-legs (*Tipulidae*), but of diminutive form. They are nearly all gall-flies, the females laying their eggs by means of the soft extensible end of the body which slides back and forth like the joints of a telescope. The irritation caused by the egg results in the swelling of the stems of plants, or the formation of tumors or galls on the leaves and buds. The Hessian Fly, as we shall see farther on, does not produce true galls in this way, but the presence of the insect in the flaxseed state, between the leaf and the stalk, causes the stem to swell, and the leaves to wither and die. The scientific name is *Cecidomyia destructor* of Say.

The female (Plate I, *f*; II, *A*.)—The body is rather slender, uniformly dark brown, the head is round, but somewhat flattened, the eyes are black, the wings uniformly dull smoky brown, while the legs are paler brown than the rest of the upper side of the body. The body, wings, and legs are provided with fine hair-like scales (Plate II, *A*, *c*), those on the wings being in many cases quite broad and ribbed, somewhat like the scales on the wings of a butterfly or moth. The pale brown antennae are about half as long as the body, the joints are very distinct, like a string of beads, each one being oval-cylindrical. There are seventeen joints, the two basal ones being large, nearly globular, flattened lengthwise, and nearly half as long as thick, and each of nearly equal size; joints 3–5 are longer than the remaining ones, and are slightly contracted in the middle; the remaining 6–17 gradually decrease in length, each joint being provided with about ten hairs, arranged in a rude whorl; the terminal joint (Plate II, *A*, *a'*) is long and conical. The legs are of the same color as the under side of the body, being a little paler than the back. The abdomen is rather full, with nine well-marked rings or segments, the

paler small ovipositor forming the tenth. The latter is one-half as thick as the ninth segment, and about two-thirds or quite as long; is slightly sinuous, and a little smaller at the end than at the base. The wings are dusky, with a fine fringe around the edge, and there are three veins. The subcostal vein ends near the outer third of the wing; the median vein arises from near the base of the submedian vein and runs nearly parallel to the subcostal vein, while a branch (its base disconnected with the main vein) extends along the middle of the wing; the submedian vein is well developed, at the base throwing off the median vein at a little distance from the base of the wing, and losing itself before turning down to the edge of the wing. The length of the fly is $2\frac{1}{2}$ millimeters, or about one line, i. e., $\frac{1}{16}$ of an inch.

The male.—The male is rather smaller than the female, being distinguished by the long slender abdomen, and the longer and more hairy antennae. The joints of the latter (Fig. A, a', a'') are twenty in number, oval, the terminal one conical, and all provided with a few hairs, much longer than in the female, and arranged in a decidedly verticillate manner. "The abdomen in the living specimen is black or brownish black, with bands at the sutures both above and beneath, of a brick red, tawny yellow, or grayish color, varying in their width as this part of the body is more or less distended." (Fitch.) The claspers at the end of the body are stout, much more so than in *Cecidomyia leguminicola* of the clover.

The egg (Plate I, a, enlarged) is very minute, about a fiftieth of an inch long, cylindrical, pointed at each end, the shell shining and transparent, the egg being of a pale red color.

The larva.—After remaining about four days in the egg state, the larva or maggot of the Hessian Fly hatches, and is of the form represented by Plate I, Fig. b, and Plate II, Fig. B, Ba, Bb, Bc.

The body is soft, smooth, shining, oval cylindrical, beneath a little flattened, and consists of twelve segments besides the head, the latter soft, fleshy, and but slightly separated from the body, with very rudimentary mouth-parts (jaws, &c.). The rings or segments are moderately convex and tolerably distinct from one another; the sutures between the segments in the living larva being indicated by faint transverse lines of a greenish brown hue, according to Fitch, who also states that the mature worm, freshly taken from the roots of the wheat, measures about 0.15 of an inch in length by 0.06 inch in width. Mr. Riley informs us that there are nine pairs of minute spiracles, which appear as yellowish rounded tubercles.

The puparium or flaxseed state (Plate I, Fig. c, Plate II, Fig. D).—When fully grown the larva is ready to transform into the third or pupa stage of its transformations. The body turns brown, and finally of a bright chestnut color, while the skin loses all appearance of sutures, and assumes a rude spindle-shaped form, somewhat larger than the larva. This brown case protects the growing pupa within the skin of the latter, finally separating from the cast larva skin, called the pupa-case or

puparium, and which serves as a sort of cocoon to protect the pale, soft-bodied pupa within. While many two-winged gall-flies are protected by the galls within which they live, others, like the larval wheat and clover seed midge and the pitch-pine midge, spin true cocoons of silk; and the Hessian Fly is the only species of the genus or family, so far as we know, which assumes this puparium state, being peculiar to the house fly and other species of Muscidae and allied families, in which the pupa is said to be *couretate*, i. e., protected by the cast dried brown skin of the maggot or larva.

From the decided resemblance to a flaxseed the insect, when at this stage of its transformations, is said to be in the "flaxseed" state. It is, however, rather flatter than a flaxseed, being pinched, as it were, at the head end of the body. I have taken the semi-pupa or incompletely-formed pupa from the flaxseed December 1. In this flaxseed state the partly-formed pupa resides during the five winter months of the year.

In early spring, during warm weather in April, the semi-pupa rapidly transforms into the complete pupal or chrysalis state.

The pupa (Plate II, C).—As we have not personally observed the mode in which the fly issues from the pupa and its case, we extract the following account from Fitch. By the time the insect reaches the pupa state the flaxseed case has become quite brittle, breaking asunder transversely if rudely handled, one of its ends slipping off from the insect within, like a thimble from the end of the finger.

The time for its last transformation having arrived, the pupa, by writhing and bending its body, breaks open its puparium or flaxseed case, crawls from it, and works its way upward within the sheath of the leaf until it comes to some cleft in the now dead, brittle, and elastic straw. Through this cleft it crowds its body until all except the tip of the abdomen is protruded into the air, the elasticity of the straw causing it to close together upon the tip of the abdomen sufficiently to hold the pupa in this situation secure from falling to the ground; and, as if to preserve the body in a horizontal position, the feet are slightly separated from the abdomen and directed obliquely downwards, with their tips pressed against the side of the straw, thus curiously serving, like the brace to a beam or to the arm of a signpost, to support the body from inclining downwards. Thus securely fixed and now freely exposed to the drying influence of the atmosphere, the outer membrane of the pupa exhales its moisture, and, as it becomes dried, cracks apart upon the back or upper side of the thorax. Out of this opening the inclosed fly protrudes its head and thorax, more and more, as it gradually withdraws its several members—the antennae, wings and legs—from the sheaths in which they are respectively enveloped—a process analogous to that of withdrawing the hand and its several fingers from a tight glove—until at length, entirely freed from its pupa-skin, the fly, now perfect in all its parts, usually walks a few steps further up the straw, where it pauses for its body and members to acquire more firmness and strength by the further evaporation of their moisture, after which it is ready to spread its wings and mount into the air.

The Hessian Fly is easily distinguishable in all its stages from the wheat midge, which belongs to a different genus, *Diplosis* (*D. tritici* of Kirby). The wheat midge is orange-colored, has a stouter body, with clear, transparent, and much broader wings, and pale-yellow legs, while the larvae are orange-colored, and live crowded around the wheat-grains

at the top of the plant; they spin a silk round genuine cocoon, smaller than a mustard seed, which remains in the ground just beneath the surface. So it will be seen that the forms and habits of the two insects are very dissimilar, and that they need not be confounded.

HABITS OF THE HESSIAN FLY.

Having become acquainted with the appearance of this two-winged gall-fly in its different stages, we are now prepared to study its habits; for an intimate knowledge of how it comports itself as an egg, larva, "flaxseed," and perfect winged fly is absolutely essential to the farmer who would endeavor intelligently to combat this pest.

Number of broods.—The Hessian Fly is double brooded; the "flaxseeds" or puparia being found on the winter wheat from late in the autumn, through the winter, until the early part or middle of April. The "flaxseeds" of this brood, from one to about twenty in number, are situated between the stalk and sheathing base of the leaf, at the roots of the young grain, slightly beneath the surface of the ground.

The "flaxseeds" of the second generation affect the wheat in the late spring and summer; but are situated higher up, an inch or two above the surface of the ground, at the lower joints of the straw.

In the ordinary course of nature, therefore [says Fitch], our crops of winter wheat are liable to two attacks of the Hessian Fly, one generation reared at its roots producing another, which occupies the lower joints of the stocks. Thus the larvæ and pupæ are present in it almost continually from the time the tender young blades appear above the ground in autumn till the grain ripens and is harvested the next summer. Our spring wheat, on the other hand, can rear but one brood of these insects; they consequently resort to it but little, if at all. Nor can the Hessian Fly sustain itself except in districts where winter wheat is cultivated in which for it to nestle during the autumn and winter.

As a general rule, then, there are two broods of the fly, the first laying their eggs late in April and in May, and the second brood of flies ovipositing* in August, during September, and perhaps a few early in October. Sometimes the flies appear earlier, as Professor Cook, who observed the insect in Michigan, says that "in July and August the flies again issue forth, and the cycle of changes for the year is complete. Thus we see that the flies are ready for work in the fall, much before the wheat is ready for them, and may attack a volunteer crop long before the usual crop is above ground or even sown."

A third brood may sometimes appear, as shown by Mr. B. Hulick, of Michigan. According to Professor Cook, Mr. Hulick found the empty "flaxseeds" on volunteer wheat in September. On Professor Cook's expressing some doubt whether the fly had issued, suggesting that it might be the parasite that had eaten the fly and come forth, as the time appeared to

* Mr. F. S. Sleeper writes us that he has on one occasion seen the Hessian flies laying their eggs as late as October 26. In February, 1873, during very mild weather, he observed them laying their eggs in February. See his statements farther on.

him too short, Mr. Hulick at once planted some of the volunteer wheat, still containing the "flaxseed," in close jars, and—

Saw many of the flies issue; and, more, had eggs laid by these flies on the same wheat in October. Mr. Hulick showed these flies and their eggs to several of his neighbors. In this case the eggs were deposited in July, the flaxseed state assumed in September, from which came a third brood of flies in October. This is certainly a very important matter, as it shows that three broods are possible under favorable conditions. That while the fall flies may, nay generally must, wait till September to deposit eggs, they only want opportunity to breed their mischief much earlier, even in July or August, and thus propagate a late brood of flies which will be in readiness for even the latest sown wheat. No doubt, too, as in the case of all insects, varying degrees of heat or cold will accelerate or retard the various transformations. (Lecture, &c., p. 9.)

Mode of egg laying (see Plate I, *e*, the fly of its natural size engaged in laying its eggs on the leaf of wheat). The mode of oviposition has thus been described by Mr. Herrick:

The eggs are laid in the long creases or furrows of the upper surface of the leaves (i. e., the blade or strap-shaped part) of the young wheat plant. While depositing her eggs the insect stands with her head towards the point or extremity of the leaf, and at various distances between the point and where the leaf joins and surrounds the stalk. The number found on a single leaf varies from a single egg up to thirty, or even more.

Professor Cook says that—

The fly very rarely lays more than three eggs at one time without change of position. She more frequently lays two, and generally but one. In case she lays but one it takes less than a quarter of a minute, and less than a half a minute to lay three, when they are all laid without a change of position on the part of the fly. After laying she seems to draw in her ovipositor soon to extend it again, at the same time crowding into it the one, two, or three eggs that are next to be laid. She then flies to another leaf, alighting usually, not always, with head towards the end of the leaf. She then appears to wipe the eggs off the jointed ovipositor. She really crowds the egg till the end touches the leaf, when by friction of the leaf and adhesion of the egg the latter is held fast while the egg-tube is withdrawn. If the second and third are to be laid she repeats the operation, after which she retracts her ovipositor, restocks it, and in a trice is depositing the fatal germs on another leaf. I say usually on the upper surface, for occasionally eggs are laid on the stalk, and sometimes on the under side of a leaf. I have observed that the fly often makes many unsuccessful efforts to cause the egg to adhere on the outer face of the leaf before she succeeds. I have seen a fly work thus for two minutes before success crowned her efforts. The fly may thus learn by experience that it is easier to deposit on the inner or upper face of the blade, and so generally choose that surface. We shall see, too, in the sequel that it is better for the prospective maggot that the egg be placed on the upper surface. In four to ten days, more or less, as the weather is cool or warm, the eggs hatch. (Lecture, p. 7.)

Mr. C. V. Riley describes as follows the process in the New York Tribune:

I have very carefully studied the oviposition of the Hessian Fly, closely observing the female in the act on several occasions; and as accurate observations on this point are not easily made, I herewith transcribe my notes of several years ago:

Eggs deposited in irregular rows in the longitudinal cavities and depressions of wheat stalks between the stalk and sheath when this is loose, or on the leaves between

the natural ridge or carina of the upper surface, this last being the more common habit. Ordinarily there are from five to ten in a row, but sometimes more. Each egg .02 inch long, cylindrical, rounded at each end, soft, translucent, and pale orange red in color. Before hatching, the pale sides of the inclosed larva show through the shell. Larva hatched in four days; crawls down leaf to base of sheath, which on young grain is at crown of root. The orange-red color is soon lost, and the larva becomes pale, translucent, and plump, sinking more or less into the stalk by the depleting process kept up.

In an article in a Saint Louis paper I described, last June, the process of oviposition on the leaves, and my own observations in Missouri accord entirely with those of E. Tilghman recorded in 1820, and of E. C. Herrick in 1844, and quoted by Fitch in his essay on the Hessian Fly (Albany, 1846), with the exception that they do not mention the exceptional habit of pushing the eggs between the sheath and the stalk, owing doubtless to the fact that their observations were made solely on the autumn brood of flies ovipositing on the young plants, the habit being more common in the early summer brood when the plants are larger.

Mr. William Strong, of Kalamazoo County, Michigan, thus describes the process, adding some particulars of interest:

I have seen the wheat plant with many of the maggots at work before there was any stalk for the fly to lay its eggs on, by introducing its extensile abdominal tip under the leaf sheath. Even this fall I have seen this very thing when there was as yet but one shoot from the kernel having but three leaves, the wheat having been sowed not more than three weeks. I have seen these maggots when too small to be seen without the aid of a glass, so low down toward the kernel, which was sowed with a drill, that if the fly had deposited the eggs under the leaf on the stalk, if there had been one there, she would have been obliged to use a spade to dig to get a chance. I am not the only one who believes that the egg is laid on the leaf and hatches there, when the small maggot works its way down inside of the leaf as low as possible. If there should be fifteen or twenty on one leaf (not a large number to find the past year under one leaf), of course as they took their places they would be somewhat in rows, but they, of course, are not the "eggs placed in the longitudinal grooves of the stalk."

In Solon Robinson's "Facts for Farmers," page 214, we read: "The female deposits her eggs soon after the wheat begins to grow, * * * in the cavities between the little ridges of the blades. In from four to fifteen days the eggs hatch and the diminutive maggots work down into the leaf sheath and there spend the winter." In the Kalamazoo Telegraph for November 7, this year, are a few lines upon the Hessian Fly by M. B. Batcham, of Ohio. He is too well known to need an introduction at this time. He says: "In the spring, with the first warm weather, the fly will come forth and deposit its eggs upon the leaf, which will then soon hatch, when the worms, crawling down the leaf, feed upon the stalk, injuring its growth, often causing it to die." A reason given by some why the fly does not injure red wheat as much as white is because the leaf of the red grows so long and slants down from the shoot so that when the egg hatches the maggot works down the wrong way, falls to the ground, and so many fail to harm the wheat.

A writer in the Country Gentleman, Mr. Caleb S. Fuller, of Jackson County, Michigan, says:

The fly commences as soon as the wheat is up an inch high. I placed in a glass fruit jar some stools of wheat which was sown on the 31st of August, and about the 15th of October the fly hatched out of the brown eggs [puparia] which were in the wheat in large numbers, and was a lively little black fellow about one-eighth of an inch long. Now, if the eggs were deposited about the 8th of September, as that is as soon as the wheat would be large enough for them, it would give them about 37 days to mature so as to fly again, though they might hatch a little sooner or later in the open field. I cannot say as to that; have no certain means of knowing.

The flies of the second brood are, in Southern Michigan, ready to deposit their eggs late in April or early in May "on spring wheat or barley which is sufficiently advanced, in lieu of which they deposit on the wheat again, not on the basal or radical leaves, but on the leaves which will be above the first or second, rarely the third, joints." (Cook.)

Habits of the larva.—As soon as the footless larva or maggot hatches, it makes its way down the leaf to the base of the sheath, which, in the young winter wheat, is at the crown of the root.

Here [says Herrick] it fastens, lengthwise, and head downwards, to the tender stalk, and lives upon the sap. It does not gnaw the stalk, nor does it enter the central cavity thereof; but, as the larva increases in size, it gradually becomes imbedded in the substance of the stalk. After taking its station, the larva moves no more, gradually loses its reddish color and wrinkled appearance, becomes plump and torpid, is at first semi-translucent, and then more and more clouded with intestinal white spots; and when near maturity, the middle of the intestinal parts is of a greenish color. In five or six weeks (varying with the season) the larva begins to turn brown, and soon becomes of a bright chestnut color, bearing some resemblance to a flaxseed.

EFFECT OF THE WORM OR LARVA ON THE WHEAT.

As has been stated, the worm in autumn lies at the sheathing base of the leaves just above the roots, at or near the surface of the soil. It is easy to detect the flaxseed from its large size and chestnut-brown color, by separating the leaf from the stalk of the young wheat in October and November, when the worm has stopped feeding and is incased in its brown sack. Scattered shoots will be found, withered and changed to a light yellow color, and, as Fitch observes, strongly contrasting with the rich green of the vigorous uninjured plants. (See Plate I, representing a healthy stalk on the right and a dwarfed plant on the left, containing three flaxseeds, with the leaves partly withered.) The worms, before assuming the flaxseed state, rest between the leaves and the stalk; their soft fleshy undeveloped mouth-parts do not enable them to gnaw the surface of the plant, but the sap is supposed to be absorbed directly through the walls of the body, and thus they are said to feed by imbibition; this weakens the plant and causes it to become unhealthy and turn yellow and die; moreover, although this point is disputed by Dr. Fitch, the presence of the worms causes the formation of a gall-like swelling or enlargement of the stalk, an abnormal growth of the plant being caused by the slight interruption to the flow of the sap. Of course when six or a dozen of these comparatively large flaxseeds are lodged under the base of the leaves the plant turns yellow and dies, as if the roots had been affected.

How a field of winter wheat may be attacked and affected by the Hessian Fly may be seen by reading the following account in the *Cultivator and Country Gentleman*:

Last fall the appearance of the wheat plant on different fields and locations was very different. On strong and level lands, little injury was shown. Hilly fields, or where there was a ridge or worn point, or where the rock cropped nearer the surface,

the wheat appeared injured or dead, as also when sown after spring grain, particularly oats. That the fly either enters the ground or remains in the dry stubble till the size of the wheat affords a lodgment, appears true. As an instance, I note the following facts: An acre of potato ground of 1876 was sown to oats in 1877. It was in fair condition, and a heavy crop was secured. Surrounding this piece of oats on three sides was a meadow, the highway bordering the other side. A good crop of hay was taken in June, and the field was all plowed in July. The after cultivation was the same, putting the field in an excellent condition for the crop. Seeding was through early in September, and in a few days the whole field was nearly covered with the growing wheat, and was very much admired, both for its beautiful green and its superior culture. All at once the wheat on the oat stubble was turning very yellow, in strong contrast to the deep green on the surrounding meadow. In the hollows, on the accumulated wash of ages, the wheat was very large and kept green and growing; while on the sharp points of knolls and hard clay ridges, it was nearly gone. On a piece of new land near by, where never a kernel of grain was grown before, no fly or injury could be seen.

The appearance of the fly was general, as soon as one or two leaves gave them a lodgment. Owing to the superior warmth and moisture of the entire fall months, wheat sowed on strong land tillered largely. The insects took the first tiller and stuck to it, while two and even four others came out and covered the ground. On poorer parts of the field the plant could not tiller so much, and here the injury showed most. Up to this date the crop has wintered well, a deep layer of snow now keeps insects and wheat alike. About the 1st of May this entire brood will be ready to deposit their eggs, and they will number millions.

That a field of wheat may recuperate after a favorable winter, and how such a field looks early in the following June, is well brought out by the following extract from the *Prairie Farmer*:

The early sown wheat that was badly eaten by the Hessian Fly last fall, but which has been apparently entirely recuperated by the remarkably favorable winter and spring just passed, is more seriously damaged by the insect than many farmers are probably aware of. I visited to-day a thirty-acre field, sowed on the 5th, 6th, and 7th days of September. Early in October it looked very badly—was yellow and showed bare ground in many places, and the plants for a long time seemed to be dwindling and growing smaller. The fine spring, however, brought it out apparently all right. It now stands five feet four to six inches high, very well headed, and seemingly good for from thirty to thirty-five bushels to the acre. I examined the field carefully in ten places, taking twenty wheat stalks as they stood in the drill row at each place, with this result: Number of stalks examined, 200; number of stalks containing the fly, 134, or two-thirds of the whole. Many of the stalks, however, had only one larva, and these will probably not be much affected. The insects are all of full size, of a chestnut color, and plainly visible in the lowest joint and the one next above—about twice as many were found in the lower joint as in the upper one. This, I suppose, indicates a loss to the crop of from 30 to 50 per cent.

We had heavy rains on the 8th, 9th, and 10th of September, I think, which suspended the operation of seeding till the 12th or after. This seems to be the dividing line, separating the fields badly damaged from those that escaped with little injury. In a part of the same field (potato ground) sowed, near the last of September, with the same kind of wheat, the number of plants examined was 160; affected with fly, 12. In other fields the rate was four to six to the hundred.

Many fields of Mediterranean are lodging. The Clawson stands well, and by reason of its stiff straw and vigorous growth promises to withstand the ravages of the fly better than the more feebly-growing and weaker-strawed sorts.

ARVINE C. WALES.

STARK COUNTY, OHIO, June 7.

Another extract from the *Cultivator and Country Gentleman* bears directly on this important point.

There is a dispute among good farmers whether wheat injured by the Hessian Fly is irreparably damaged. Mr. F. C. Root thinks it is, as he says when the central stalk is eaten out the plant is either dead, or able to make only a feeble growth. If it makes a head, it will perfect only one or two seeds to a plant. Mr. Jesse Dewey qualifies this statement thus: *If the land is rich enough*, though the central stalk be injured, the wheat plant will stool, and from its side roots send up stalks and perfect a fair crop. I have no doubt that both of these excellent farmers are right. On the great majority of fields, the injury to the wheat plant in the fall means the destruction of the crop. When the central plant has been injured, the side shoots have not enough vitality to perfect much seed. Yet there may be land rich enough to make a crop from the second growth, provided the Hessian Fly next spring is not numerous enough to do serious damage. Very much now depends on the character of the coming winter. A season which, under ordinary circumstances, would be favorable, may also save myriads of Hessian Flies. There was much more "crinkled" wheat last summer than usual, and I have little doubt that the cause is to be found in the heavy mantle of snow, which preserved a greater number than usual of the Hessian Flies through the winter. The wheat crop this fall would have suffered more than usual in any event, but the evil has been greatly aggravated by the warm and generally dry weather after wheat-sowing. We had no killing frost until near November, nor frost of any kind until the middle of October. With frosts in their usual season, and not sowing too late, there need be little danger from the Hessian Fly. But it is the poorness of the soil which leads farmers, year by year, to sow their wheat earlier in order to get a larger growth. Making the soil richer removes the difficulty by removing its original and principal cause.—W. J. F., Monroe County, N. Y.

INFLUENCE OF THE WEATHER AND FAVORABLE AND UNFAVORABLE SEASONS.

To properly discuss this very important subject would require an intimate knowledge of the meteorological conditions and the relative abundance or rarity of the Hessian Fly during each year since its first appearance in this country in 1776. All that we can say with our present exceedingly imperfect knowledge bears but slightly on this point and must be considered as simply provisional. We may here quote from the *Cultivator and Country Gentleman* what has been stated by Mr. Riley in speaking of the condition of the Hessian Fly in 1877 :

The Hessian Fly is rather an insect of moist climates and mild latitudes; and therefore, unlike the chinch bug, its multiplication has been favored by the cool and wet summers and autumns of the last three years. While the rainy period which as a general statement may be said to have commenced in May, 1875, and continued to the present date, and during which time there have neither been severe droughts, nor continued summer heats, the chinch-bug has so nearly disappeared that its depredations have been scarcely noticed, the Hessian Fly has developed and thrived, and to the extent that if the weather favors—that is, if from now to harvest it should continue cool and moist or warm and wet—the damage likely to be done to the incoming and the following crop can scarcely be estimated. But if dry weather prevails from this time to harvest, the damage done can hardly be considerable—and if it should turn very dry and hot, all danger from serious depredations from him may be cast out of the account, in measuring the outcome of the crop—since a certain amount of moisture is absolutely necessary for the successful development of the several stages in the growth and progress of this insect scourge. But then Professor Riley warned

me against drawing final conclusions on insufficient data, it being quite possible that other forces and causes appearing might bring about a quite different and unexpected result. Nevertheless, there are many reasons for expecting a dry spring, a warm harvest, and a hot summer, and comparatively trifling damage to be done by the fly on the wheat harvest of 1878.—W. J. F.

That this fly flourishes best in a rather warm and moist season, is shown by its habits. The flies hover in the spring and autumn over the wheat-fields in countless numbers, especially at morning and evening, avoiding the direct heat of the sun.

PARASITES OF THE HESSIAN FLY.

How useful, nay indispensable, parasitic insects may prove in keeping the noxious ones within due limits is well illustrated by the case of this fly, for whenever it suddenly disappears from a given locality, this is usually due to the attacks of its parasites, and especially one Chalcid fly, the *Semiotellus destructor*, first described by Say.

This is a hymenopterous insect, having four wings and belonging to the same order of insects as the saw-flies, four-winged gall-flies (*Cynips*), the larger ichneumons, and the wasps and bees. It is a member of the family *Chalcidæ*. As stated in our *Guide to the Study of Insects*, this is a group of great extent, the species being of small size; they are often of shiny colors, as the name of the principal genus implies, being either bronze or metallic. They also have elbowed antennæ with from six to fourteen joints, and the wings are often deficient in veins. The abdomen is usually smaller, and composed of seven rings in the male, and of six in the female, the latter often having a short but visible ovipositor, a horny tube consisting of three pairs of stout bristles closely united and forming a quite solid tube. Some species are wingless. There are 1,200 species of the family known in Europe, and there are, in all probability, at least 1,000 in the United States. Few of them are over a line in length.

Semiotellus destructor, male. (Plate I. Fig. *i* much enlarged.) The head is transversely oblong, or rather cubical, being rather wider than long, and slightly broader than the thorax when seen from above, being full, somewhat rounded in front, and hollowed out behind next to the thorax. The eyes are dull red, reaching, when seen above, behind the middle of the head. The antennæ are elbowed, and when bent back reach to about the middle of the thorax; they are yellow on the basal half, black beyond. For a further account of the antennæ we quote as follows from Fitch, our specimens being defective in this respect:

In the male they are of uniform thickness through their entire length. Viewed with a common magnifier they appear ten-jointed, though the last joints are usually so compacted that in the dried specimen the full number cannot be distinctly discerned. When highly magnified two small additional transverse joints may usually be discerned, more or less distinctly, between the second and the third joints, of which the first is rather smaller than the second. The joints are slightly longer than thick, and rather narrower towards their bases. The second joint is longer than the others, its length being about double its thickness. The last joint is more than twice as long as

thick, its apex appearing to be cut off transversely, with a minute teat-like process protruded therefrom.

The thorax is about twice as long as broad, and widest at the insertion of the fore-wings; like the head, the crust is coarsely punctured. The fore-wings are broad, triangular, well rounded externally; the subcostal vein is very thick, being strongly marked, and after joining the costal or front edge of the wing for a short distance, just beyond the middle of the wing, is bent in towards the middle of the wing, ending in a knob-like expansion with a slight point extending towards the costal edge of the wing. Fitch represents a slightly marked vein extending to the outer edge of the wing, but this is absent in some specimens. There is an incomplete median and submedian vein, only perceptible under strong magnifying powers, the base of the median being quite disconnected from the submedian. In one of my specimens there was no vein extending from the subcostal knob to the end of the wing.

The legs are pale straw-yellow, the fore shank-joints (tibiae) and toe-joints (tarsi) brownish; the third hip-joints (femora) are dusky on the basal half, while the hind terminal tarsal joints are brown. The abdomen is small, black, while the head and thorax are bright metallic green, sometimes blue. The abdomen is also smooth and polished, much flattened, oval, not so wide as the thorax, broad at the end and suddenly pointed (mucronate) at the tip. It has a large yellowish patch on the upper and under side of the second segment. Length of the body 2-2½ millimeters (.08-.11 inch).

The female differs in her greater size and rather slenderer body, and the more club-shaped antennae, the terminal joint being twice as long as thick. The abdomen is as long and as wide as the thorax, ending in a long sharp point, the short but distinct ovipositor extending slightly beyond the tip of the body. There is a slightly marked pale spot above on the second segment. Length 2½-3 millimeters (.10-.12 inch).

This parasite was first described by Say, his specimens occurring at or near Philadelphia; it was observed by Herrick in 1833, in Connecticut, and in 1877 we bred it from puparia of the Hessian Fly received from Ohio; and, as stated by Professor Cook, it is sufficiently abundant in Michigan to destroy the Hessian Fly in great numbers, and is probably distributed throughout the Hessian Fly area.

So destructive is this and other parasites to the Hessian Fly that as early as 1841 Herrick claimed that in Connecticut "a very large proportion, probably *more than nine-tenths*, of every generation of the Hessian Fly is destroyed by parasites." This work is mainly, we doubt not, done by the chalcid parasite under consideration. It is to this insect more than to any other means in nature that we owe the general immunity in certain years from the attacks of the Hessian Fly in most wheat regions, and to this cause that during certain years the fly is kept wholly within bounds. Few people, even naturalists, have any adequate idea of the good done by these minute parasites. What was the fact in Connecticut,

in 1841, and the few years preceding, has been the case in Michigan, according to Mr. F. S. Sleeper, of Galesburg, Mich., who writes us that the Hessian Fly was nearly exterminated in Kalamazoo County by *Semiotellus destructor*, nearly all the "flaxseeds" in the crop of 1877 having been destroyed by this friendly parasite. He writes us that in the autumn of 1877 he found these parasites in the wheat-fields in countless numbers, and that the perfect Hessian Fly was difficult to find.

No one since Herrick recorded his observations has made very careful observations on the habits of these parasites. He states that:

It pierces the sheath of the stalk (making a hole too small to be detected by a powerful microscope), and deposits an egg in the pupa within. This is done chiefly in June. The perfect insect is evolved in the summer and autumn succeeding, eating its way through the puparium and the sheath of the leaf.

Herrick also states that a second parasite, very similar to the *Semiotellus destructor*, "but with mere rudiments of wings, is sometimes evolved from the pupæ of the Hessian Fly. I am in doubt whether it should be considered a distinct species or only a variety."

A third parasite was reared by Herrick in Connecticut. It is an insect of the tribe *Chalcidiae*, whose genus he did not determine. Its habits were like those of *Semiotellus*, and wingless females of this species were also found.

A fourth parasite, noticed by Herrick, belongs to Latreille's tribe *Oxyuri*, but the genus was not determined. In habits it agreed with the foregoing parasites, but it was evolved later in the year. Herrick adds that all the parasites mentioned "are likewise evolved in the spring from the Hessian Fly pupæ of the summer previous."

The fifth parasite has quite different habits. It lays its eggs in those of the Hessian Fly. Herrick, its first discoverer, thus speaks of it:

The insect is abundant in the autumn. I first saw it September 23, 1833, in the act of depositing its eggs in the eggs of the Hessian Fly. From subsequent observations it appears that four or five eggs are laid in a single egg of the Hessian Fly. The latter egg hatches, and the animal advances to the pupa state as usual, but from the puparium no Hessian Fly ever comes forth. This parasite forms within the puparium a silky cocoon of a brownish color.

It is probable that it is the species first discovered by Herrick in Connecticut which Professor Cook has detected ovipositing in the eggs of the Hessian Fly.

It is black and looks not unlike a tiny gnat. The female feels for the egg with her antennæ, and when found intrudes the fatal egg, which, I find, takes three-fourths of a minute; full three times as long as it takes the Hessian Fly. The little parasite is much longer, too, in finding the eggs than is the fly in laying them. I find that each egg receives one, two, or three of the parasite's eggs. The eggs of these latter are tardy in hatching, so that the larva of the parasite may feed on the maggot of the Hessian Fly, not her eggs. These pupate in the puparium of the fly."

Platygaster error Fitch ?.—Having received one of these egg-parasites from Professor Cook, I find it to be so much like the *Platygaster error* of Fitch (Fig. 1) that I refer it to that species, though with a doubt. This is probably also the parasite referred to by Mr. Herrick.

It is shining black; the head is finely punctured, rounded, and slightly broader than long, being about as wide as the thorax. The antennæ are about as long as the head and thorax; they are slender, but apparently a little stouter than in *P. error*, the penultimate joints being a little broader and squarer than he represents (and they are very different from *Platygaster tipulæ*), these joints not being "twice as long as thick," but only $\frac{1}{4}$ to $\frac{1}{3}$ longer, much as represented by Fitch in his figure;* the terminal joint is long, oval, not so wide as those just behind it, and it tapers to a

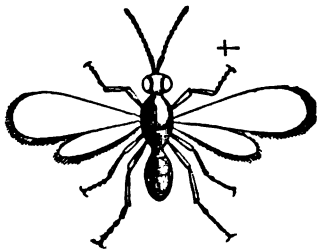


FIG. 1.—Egg-parasite of the Hessian Fly.

rounded point. The thorax is rounded ovate, but little longer than broad, black, with the scutellum high, rounded and pitted. The abdomen is flattened, oval, twice as long as wide, being a little longer than the thorax, but not quite so wide. The legs are pitchy black on the femora; the tibiae dull reddish brown, darker towards the end; the tarsi are 5-jointed, dark brown, hairy, with the basal joint reddish at the base. (Fitch says the legs of *P. error* are pitchy black; but in the specimen before me they have a decided reddish tinge.) The wings are veinless, clear transparent, irised. Length $1\frac{1}{2}$ millimeters, being a little larger than Fitch's *P. error*, which was .05 inch long. I am disposed to refer this specimen to Fitch's species, but should it be found to be quite distinct, it may receive the name *Platygaster herrickii*. It seems to be a genuine *Platygaster*.

Fitch states that *Platygaster error* is seen in company with the wheat midge (*Diplosis tritici*) on the wheat ears in New York, and is very numerous some years, but he thinks it doubtful whether it preys upon the midge.

REMEDIES, PREVENTIVE AND GENERAL.

Having become familiar with the habits of this insect, which can be readily observed by farmers, it is not difficult to apply such remedies as the experience of wheat raisers of the past century in different parts of the wheat region of the United States has nearly universally found serviceable. Remembering that the first brood of flies appear in August and continue to hover over the fields until late in September, as if waiting for the fall-sown wheat to appear, it is evident that by delaying the date of sowing until after a frost cold enough to kill the flies, they may be circumvented; for if the wheat is sown later than the 20th of September in nearly all the Middle and Northern States, the early frosts will destroy these delicate insects. Late sowing, then, is the most general, important, and easily applied preventive remedy.

Late sowing of most of the wheat-seed.—All writers, both entomological and agricultural, concur in recommending this easily-applied remedy;

* Sixth report on the noxious and other insects of the State of New York, by Asa Fitch, M. D. Pl. 1, fig. 4, a, b. The figure is from Packard's Guide to the Study of Insects.

that at least a part of the wheat should not be sown until after the 20th of September in the Northern States. The writings of Fitch, Harris, and of Cook concur in recommending this course in a district ridden by these pests, even though the wheat is in danger of being injured by the cold autumnal or the winter weather. As the year 1877 was a bad fly year, we quote the following explicit testimony from Professor Cook's pamphlet:

In all the century's experience in our country with this insect, this has been the most certain and satisfactory method to prevent its ravages. Even more than thirty years ago this measure is spoken of as unanimously sanctioned and the most efficient of remedies. During the past season [1877] I have reliable reports from the following counties: Ottawa, Van Buren, Cass, Kalamazoo, Hillsdale, Saint Joseph, and Lapeer, and with few exceptions it is stated that early-sown wheat was injured badly, while all sown after September 20 nearly escaped. In traveling through Ohio and Southern Michigan, I found I could often tell the early from the late-sown wheat for long distances, the former looking like oat-plants after a hard frost, the latter appearing green and healthy. Often in the same field the line of demarcation was very distinct

The following newspaper extracts bear upon this subject:

Perhaps the most effectual remedy, or rather preventive, is late sowing. No wheat should be sown in localities where they have already appeared, or in districts adjoining, until September 15, and if it is deferred until the 20th it would be all the better. Repeated rolling is said to destroy some of the larvæ, and burning the stubble, where practicable, would certainly destroy many and thus prevent so great devastation of the succeeding crop. The great objection to either rolling or burning is that it destroys both friend and foe alike.

Great care should always be used in destroying all noxious insects lest we also destroy the beneficial ones; the chief of which are the Ichneumon and Chalcid flies. In the counties of Yates, Seneca, Tompkins, and Cayuga, where the Hessian Flies have already made their appearance, it would appear wiser to fit the ground perfectly, apply extra fertilizers, and sow late, rather than run any risk or trust to any methods of destruction. If all infested and contiguous districts would sow late enough so that the wheat would not appear above ground before September 25, I believe the fly could be effectually starved out.—[I. P. Roberts, professor of agriculture, Cornell University, in the *Rural New Yorker*, September 8, 1877.

By the attacks of this (the second or spring) brood of worms, the lower joints of the wheat are weakened, and as soon as the head is formed, and the growth is heavy, the weakened joints give way and the wheat falls over, or, as it is commonly expressed, it "crinkles." If but few larvæ are at work, there will be some kernels of grain in the heads thus affected, but they will be more or less shrunk. If the insects are plenty, the head seldom "fills," and the field looks as if cattle or something else had passed through it, tangling up and throwing down the straw in every direction.

There are thus two generations of the Hessian Fly each year, one of which subsists and may be always found at the crown of the roots, and the other at some joint above, and never at the root. If the wheat could be fed off by sheep in the fall, between the time that the eggs are laid and the time of their hatching, this remedy would be perfect. Unfortunately, the wheat is then young, and farmers do not like to risk thus seeding it off. The only remedy left, therefore, is to sow so late that the wheat will not appear above ground before October 1. In this case there is the added risk of winter-killing, because the plants have not time enough to get well rooted before winter. On well-drained, rich land, this danger is greatly prevented, and therefore late sowing and thorough farming seem to be the only available means yet discovered to avoid great losses from the ravages of the Hessian Fly. Fortunately the parasitic enemies of the fly increase rapidly, and after a year or two of great losses from this insect its numbers are reduced so much as scarcely to be noticed for some years.—[*Chicago Tribune*]

I find in several counties of Northern Ohio, where I have traveled of late, a good deal of injury is done to the young wheat by the fly—more than has occurred before for quite a number of years. This is no doubt owing to the general practice of sowing wheat early, and the fact that it made a remarkably fine growth during September, when the warm weather was also very favorable for the propagation of the flies. The worms have now gone into the pupa or “flaxseed” state, and if the winter is not too wet or cold for them, it is likely the new brood next spring will prove quite mischievous.—[B., *Cultivator and Country Gentleman*.

Pennsylvania German farmers have a claim to be considered good zoologists by their knowledge of animals, from the noble horse down to the insect tribe, that so beset them with labor and loss. The German farmers have been apt and successful in contesting the insect enemies of all crops. The wheat midge, which came in upon us twenty years ago in vast numbers the last of June and the first of July, made his home in the wheat-heads, and nurtured his progeny in the cell prepared for the expectant berry, and appropriated the element nature designed for the perfection of the seed to his own use. This insect for a time literally destroyed the wheat product. Whether it was a scientific discovery that taught the farmers of Lancaster County how to get rid of this destructive insect or not, I have never learned. But I do know that I purchased and carried to my farm Lancaster red wheat which I was instructed to sow in August, and in doing so freed my farm of this pest. Continued early sowing proved successful up to the present season, when this practice brought the Hessian Fly, who begins at the root of the wheat plant. If the mother fly can get an opportunity to deposit its eggs in the fall season, the larva will stand the winter imbedded in a stalk of wheat (which is a well-tillered plant), and brings forth enough Hessian Fly to destroy the wheat before harvest time. The habit of this Hessian Fly is to bury in the ground with the first frost of the fall season. A Lancaster farmer said to me not long since, we must sow our wheat late this fall if we would avoid the fly. Early-sown wheat was a failure in Pennsylvania to an extent, in my estimation, that reduces this cereal 30 per cent. below our general average. The corn crop over the entire State is not an average one. The oat crop is above the average. The buckwheat crop, generally relied upon in the northern and western portions of our State as one of the paying bread grains, has been very extensively injured by the grasshopper, and cannot be expected to yield more than one-half the usual amount.—[V. E. Piollet's address before the Berks County Agricultural Society, at Reading.

The letter below from W. B. Billings to the Elmira (N. Y.) Farmer's Club, elicited the appended discussion, as reported in the *Husbandman* :

I have perused your club reports with much interest, especially those relating to the Hessian Fly. In an experience of fifteen years of wheat raising I have had about four acres of wheat destroyed by this pest. Eight years ago I sowed a field of ten acres to wheat, four acres of which were gravel, the remaining six acres being of sandy loam, in places so wet that I had to under-drain it. Wheat put in in good condition; land new—had been in cultivation only the two previous years. Now for the results: During the fall the wheat on the gravelly part started quicker, and when winter set in looked better, the fly doing no appreciable damage to any part of the field; but in the spring when the wheat had apparently reached about six inches in height, that on the gravel commenced turning yellow about the roots, and from that time forward grew thinner and most beautifully less until harvest, when I cut it with a mower and raked it with a wheel-rake, getting about as much straw as farmers generally get from raking a like amount of ordinary wheat stubble. On the remaining part of the field the wheat was good, no noticeable damage being done by the fly. A few years previous to this I knew of a field of spring wheat that was almost entirely destroyed by the Hessian Fly, less wheat being harvested than was sown. It is generally conceded that there are two crops, or hatchings, of the fly during the growth of the wheat; the first in the fall and working until frost comes; the second in the spring, and continuing its depredations until harvest. Late sowing is generally recommended as a preventive. Why should it be so? How do you account for the fly working in wheat

growing on warm gravelly land, while that on the moist soil escaped harm? If, as above assumed, there are two crops of insects hatched per year, how does late sowing prevent their depredations? And how can you account for the loss of the spring wheat crop mentioned? Where was the first or small crop hatched, and where did the flies remain until spring? Fresh lime is recommended as preventing the ravages of this pest; can you tell me at what particular time, spring or fall, the lime should be sown to cause the greatest destruction of the fly? Any information from the club on the subject will be thankfully received.

J. S. VAN DUZER. It must not be assumed that the flies which damaged the spring wheat were hatched in that field. The parent flies may have come from a distant field.

President HOFFMAN. To my mind the case is easily explained, so far as the spring wheat is concerned. The fly is migratory. We are told by those who have studied its habits that it flies over districts as much as twenty miles in breadth in the course of the year.

The writer furnishes the explanation of the greater damage done by the fly on his gravelly land. There the wheat came earlier, and was therefore in condition to receive the deposit of eggs, while the more backward wheat was not. It accords with the theory that late sowing is a measure of prevention against the ravages of the fly. I had last fall an illustration of the protection afforded by late sowing. On a small piece I wanted to sow wheat after wheat. Before plowing the stubble the volunteer crop had made a growth of perhaps six inches. In examining one of the plants I found twenty-five of the larvæ. In many others there were a dozen or more. I destroyed this growth by thorough cultivation, and, after proper fitting, sowed the seed. In the plants that came from that late sowing there were very few larvæ. They came too late to receive the eggs. It is well known that the fly deposits the eggs on the leaves of the wheat, and that its work ceases after some frosts come. The late sowing brings the growth too late for the fly. The fly which does the mischief in the spring is not hatched in the fall—or at least is not fully developed. It comes out in the spring, lays a new crop of eggs on the leaves of the growing plants, and the insects which hatch from these eggs are those which do the real injury to the wheat. If the time can be ascertained when the eggs are deposited on the leaves, then is the time to sow lime. I do not know that it will prevent the eggs from hatching. My observation of the work done by the fly has taught me one lesson. It is that no wheat should be sown except on rich land, where the plants will be strong and therefore able to resist the ravages of the insects.—[*Western Farmer's Journal*, March 29, 1873.

It should, however, be borne in mind that late sowing exposes the wheat to the attacks of the wheat-midge (*Diploxis tritici*) and also to the rust, while also by late sowing the plants are less advanced and less fitted to withstand the rigors of the winter.

Early sowing as a remedy.—Still there are some who adhere to early sowing, as on the whole the best thing to do. We insert the following testimony in favor of this procedure:

In your paper of December 6, 1877, there are three or four articles respecting the Hessian Fly, and they are so different from my observation of the wheat insect, as we call it here, that I send you a few lines respecting the damage done to wheat here. The last harvest was very much injured in some localities in this State; in the west part of Calhoun County on sandy land some pieces were not harvested, and others yielded from five to ten bushels per acre. In this part of Jackson County wheat did not suffer so much; some fields on bur-oak soil yielded as high as 35 bushels per acre of the Clawson variety.

The fly commences as soon as the wheat is up an inch high. I placed in a glass fruit jar some stools of wheat which were sown on the 31st of August, and about the 15th of October the fly hatched out of the brown eggs which were in the wheat in large

numbers, and was a lively little black fellow about one-eighth of an inch long. Now, if the eggs were deposited about the eighth of September, as that is as soon as the wheat would be large enough for them, it would give them about 37 days to mature so as to fly again, though they might hatch a little sooner or later in the open field. I cannot say as to that, having no certain means of knowing. Now if we wait till the first of October to seed we will be just in time for the first brood that comes out in the fall to deposit their eggs in the late sowing, which was the case hereabouts. Fields sown on the 25th of September, 1876, suffered more than that sowed on the 25th of August the same year, not three miles apart; the latter giving a good crop, and the former a very light one.

Now, my observation as well as practice is, that the earliest seeding is the best every time. There are a few farmers in the country who invariably sow early,—say as early as the 25th of August—and they hardly ever fail of a good crop. There may be a difference in varieties in resisting the ravages of the fly, and I presume there is. The Tappahannock suffered very much more than the Clawson in adjoining fields, on the same farms, and sowed about the same time. I venture the suggestion that we all sow our wheat earlier—say on the 20th of August, or soon after—as farmers used to do 50 years ago, so that our wheat will get a strong root and a large top to go into the winter with. I hope this suggestion will stir up some scientific man, like Professor Riley of Missouri, to investigate the habits of the fly as thoroughly as he has the locust or the Colorado potato beetle, for I think the country has suffered quite as much from the Hessian Fly as from all other pests put together. If this brings out the desired information, I shall be well paid for this my first contribution to your valuable paper, which I have read with great pleasure for the last ten years.

CALEB T. FULLER.

JACKSON COUNTY, MICHIGAN.

In reply to your request for information in regard to the Hessian Fly, I will state that only a few of the earliest sown pieces are affected in this and the adjoining county of Trimble. Wheat in general looks remarkably well, has tillered finely, and there is at least 15 per cent. more than an average acreage sown.

S. E. HAMPTON.

CARROLL COUNTY, KENTUCKY.

[*Cultivator and Country Gentleman.*]

We may, then, conclude that, on the whole, late sowing is the best general remedy, but still a part of the wheat should be sown early as a decoy to draw off the flies and induce them to lay their eggs in the early-sown grain, that the later sown portion may escape their attacks, and then farmers should plough under and resow the fields of early grain. Hence we indorse the following excellent advice, which was first suggested by Dr. Fitch, and reiterated by Professor Cook, as follows:

Let all, without exception, sow a narrow strip about each field, to be sown early in September, or even in August. From the fact that the flies are already in waiting, that the outer edge of a field is almost always the most injured, except that the field grew wheat that nourished flies the preceding year, and that such fields suffer most, one may expect this early-sown narrow rim to receive nearly all the eggs. Leave the balance of the field till we feel it is dangerous to wait longer, at least till after the middle of September, then sow it, after which plow deeply under the early-sown strip, that is if it is stocked with insects, which may be easily determined by examination, and resow it. We should thus kill two birds with one stone—save our crops, and destroy the pest.

Advantage of high culture.—Many farmers advocate high culture, sowing a less breadth of wheat, and cultivating the ground, using fertilizers. This is all-important, as the stronger and more luxuriant the growth of

the young wheat, the better able will it be to withstand the weakening effects of the maggots; while high culture will carry a partly infested field of wheat through, when the same grain grown on a poorer soil would succumb. The value, then, of good farming, conducted on scientific principles, the forcing of the plant by fertilizers, and the rotation of crops, is so self-evident that we need devote no more space to this subject, except to add the following remarks by practical farmers:

It is claimed by some that certain varieties of wheat are less liable to the attacks of the Hessian Fly, and entire exemption has been claimed for some. I am satisfied from experience that these claims are partially fallacious. There is no wheat which the fly will not injure under favorable conditions for its working. The supposed exemption is due to the fact, that when a weak-growing and strong-growing variety are sown side by side, the fly leaves the latter for the former. Whatever makes the wheat plant vigorous, helps to repel the attacks of all insect enemies. If the red sorts are less liable to injury, it is because their thicker and ranker leaves keep the plant too moist for the eggs and larvæ. I have seen the same result from the use of superphosphate, gypsum, salt, and in fact any manure which causes vigorous growth, with dampness. Coarse manure sometimes seems to favor the insect, but only, I imagine, when the weather is so dry that its coarse strawy substance is really more dry than the ground. Wherever the soil is moist, and wheat makes a rapid growth, the fly will do least damage. I shall take advantage of this fact, this fall, in fertilizing my wheat more liberally than ever before, using two hundred, or perhaps more pounds, of phosphate per acre, besides gypsum and salt to dilute it. If I can get a vigorous growth of wheat from the start, there will be less to fear from the fly. This liberal manuring will also enable me to defer sowing till later than would otherwise be safe.

Rolling and compacting the ground is very important as a means of keeping it moist. I shall not roll immediately after sowing, but wait until the wheat is up, when, if there is a dry time with no frosts to keep back the fly, I shall roll the ground with the hope that the roller will destroy at least some of the eggs which the fly may have laid.

W. J. F.

MONROE COUNTY, NEW YORK.

[*Cultivator and Country Gentleman.*]

In the rapidly increasing practice of extra manuring and cultivation of wheat, as by drilling and hoeing, it is found in very many cases that the Hessian Fly and other insects are far less troublesome than on the wheat fields where only ordinary cultivation is practiced. It frequently occurs, too, that superior cultivation permits of earlier sowing in the fall; the extra growth more than offsetting the damage done by the insects, to avoid which most farmers now are obliged to resort to late planting. Several examples are cited where drilled and cultivated fields, grown beside ordinary broadcast-sown and lightly-manured fields, with results wholly in favor of the former, the Hessian Fly greatly damaging if not totally destroying the latter, while the cultivated fields escaped almost unharmed.—[*Cultivator and Country Gentleman.*]

Pasturing with sheep.—Many farmers practice pasturing wheat fields with sheep or cattle; for it is claimed that if the wheat is strong enough by the middle or end of November to bear it, enough of the larvæ or flaxseeds may thus be destroyed to save the wheat and prevent the necessity of plowing it in. This is a rather rude, uncertain remedy, but can be carried on with more or less success in the Middle States. We give the opinions of those who have found pasturing successful.

From Mr. E. A. Hickman, of Independence, Mo., we obtain the following information:

In reply to your inquiry on the subject of the Hessian Fly, I will state that I have made some inquiry of our best wheat-raisers, and they report as follows: First, the wheat-

midge is not found in our State, hence is not further alluded to. A. L. H. Crenshaw, now an old wheat-raiser and quite successful, says he breaks up his ground in July and lets it lie till September, then harrows it into good planting condition and lets it remain until after a *killing frost*, which is usually from the 25th September to the 5th of October, then he puts in the seed by drilling. He has never lost a crop or had one injured by the fly.

G. W. Compton is a successful raiser; he breaks up in July, and by the 1st of September sows his wheat immediately, and as soon as the wheat is up and of sufficient height he turns sheep and other stock on it to keep it eaten down so that the fly can not shelter under its leaves. This has protected his crop until the fall of 1877, when the rains favored the breaking up of the ground and the planting and growing of the wheat to such an extent that the stock could not graze it down. Its rankness protected the fly and its abundance nearly destroyed his crops. He attributes his failure to the fact that his crop was not grazed sufficiently close.

Mr. James Lobb sowed early in September, 1878, a fine growing season; brought up a luxuriant and vigorous stand; no pasturing was applied either in fall or spring, and the crop only yielded about four bushels per acre, the balance being destroyed by the fly. This was adjoining a field that produced a fine crop, but cultivated to thwart the fly.

Two other successful men say they have followed the advice of an old settler, who told them to have everything ready, but never sow until after a *killing frost*; and they never suffer from that enemy.

Mr. Robert McNeilly, of Charlotte, Dickson County, Tennessee, writes us that "the best preventive found here is to pasture the wheat close in the winter with sheep."

We also reprint the following newspaper articles:

Another error is that pasturing will do no good. If sheep enough are turned in to eat the wheat down close before the eggs hatch, after being laid, very much good will result. This is an old remedy, and has proved very effectual in many instances. It is now too late to employ it, as the eggs are mostly hatched. During the fine weather of this fall, so far, very few days only were required to hatch the eggs, after which nothing could be done. Very few eggs are placed too close to the ground to escape the teeth of sheep, and if enough of these animals could be turned on to eat the wheat off within three days after the flies appeared, very little damage would result. Frost now will not do much good except with fields that have been sown late, where the blades have not grown large enough to attract the fly. The destruction of the entire crop does not follow the appearance of the fly always. Unless very badly infested, if the soil is rich and the season favorable, a fair crop may result in spite of the fly. Of course, the crop is always injured to some extent. The best remedy, after the larvæ have hatched and found security in the crown of the plant, is to stimulate the ground as much as possible by the application of fertilizers.

We mentioned in last week's issue that the Hessian Fly appeared in Pennsylvania as well as in Canada and other sections last year. It appears that the practice of early sowing has lately increased so much in Pennsylvania as to furnish everywhere the young winter wheat at exactly the time when the Hessian Fly is laying its eggs. This probably has a good deal to do with the trouble in Canada also. And yet the evils of late sowing are so great that most farmers would prefer to risk the Hessians. A correspondent of the Germantown Telegraph, speaking from experience—for he says that he has never known his system to fail both to destroy the fly and to greatly benefit the crop—gives a useful hint. He says that if the land is strong, the eggs of the fly may all be destroyed and the crop greatly benefited in this manner: After frosts cease in the spring, and the grain is beginning to grow rapidly, and the ground has become so dry that tramping will not injure the crop, pasture off the grain down to the crown of the plants with sheep. This will remove all the eggs, and it will

cause the plants to tiller profusely, often five to seven to one, and all starting together will each enjoy equal facilities for growth and maturity, and the crop will be greatly improved and increased. If the soil lacks fertility, it is well to apply a proper amount of a proper fertilizer when the sheep are removed. If no salt has been applied to the land, no application will be more likely to pay so well as this, at the rate of twelve to twenty bushels per acre. This is well worth trying.—[*Canada Farmer*.]

Sowing of hardy varieties of wheat.—When the stalks and leaves of certain varieties of wheat are tough and hard, the stems coarse and silicious, and the plants “tiller” or throw out secondary shoots in a vigorous way, such varieties are naturally the most fly-proof and should be selected for sowing as winter wheat, while the less hardy and vigorous kinds should be sown when the attacks of the Hessian Fly are not to be expected.

Of the different varieties of “fly-proof” wheat, the Underhill variety has for nearly a century been highly recommended. As Fitch remarks, its fly-proof qualities were supposed by many to be due to the hardness or solidity of its straw. The fly laid its eggs freely upon the leaves, but it was seldom if ever materially injured by it. It is a bearded white chaff, with a plump yellow berry, requiring to be thoroughly dried before grinding, and then producing flour in quantity and quality equal to the best of the other varieties.

The Mediterranean wheat is, in the Middle States, in high repute for its fly-proof and hardy nature, recovering better than other varieties from the attacks of the fly. A correspondent in Charlotte, Tenn., writes us that “the Mediterranean, Red Chaff, and Red May are less liable to be damaged by the fly than any we have tried.” Fitch says the Mediterranean wheat is a slight red chaff, having a long, stiff beard, a long, red, and very flinty berry, and ripens about ten days earlier than other varieties. In Central New York the Lancaster, a red variety, is strongly urged.

In Michigan the Clawson is apparently the favorite wheat, on account of its “fly-proof” qualities. As stated by Professor Cook—

The fact that last summer (1876), as well as this, when Diehl and Clawson were sown side by side, Clawson was comparatively free from insects, and, as stated by Mr. Rowe, did not break down in summer, seems to show that it is more exempt from attack. It would seem that the insects have a preference, but will accept plain fare rather than starve or fail to produce. It also seems clear that Clawson, Lancaster, and the red varieties will stand attacks with far less damage, owing to their vigor and greater tendency to sprout.

He then gives the following advice:

If wheat must be sown early, so long as the Hessian Fly remains a pest, by all means sow Fultz or other varieties of red wheat, or, better still, Clawson. But if we act more wisely still, and set the trap of an early-sown strip, let this be sown to Diehl, the better to attract the flies, and then, when we sow the balance of our field, two or three weeks later, sow Clawson or other rapid, vigorous growing varieties, which not only resist attacks better, but survive better when attacked. Lastly, if the early-sown area is harboring the pests, convert it into an insect cemetery, using the insects to fertilize a still further crop of Clawson.

Mr. W. L. Devereux, of Clyde, N. Y., gives us his experience with the fly and the best varieties to sow:

Now, concerning the fly: It is the least to be feared of all the injurious insects of the United States. I am situated in or just north of the starting point of the *Cecidomyia destructor* in this last crusade on wheat, which is Seneca and Tompkins Counties, New York, between Cayuga and Seneca Lakes. This section is also where the *Clawson* wheat originated, and I hold that the *Clawson* has been the propagator of the fly in this last spread. Perhaps the Soules helped the spread prior to this.

To my knowledge, there isn't a single instance of a field of Lancaster being injured by the larvæ of the fly. Indeed, I never could find a single larva or pupa in a field of Lancaster. It is the kind which farmers have sown almost entirely throughout this section this year. It does well, and, although a red wheat, it now commands as high if not higher price than *Clawson*.

I would particularly impress upon you the fact that we think the fly cannot be found on Lancaster wheat. It is a variety which is extremely tough and hardy, having that green color which farmers call "black," while the *Clawson* and similar wheats have a green color which is very often yellow. The Lancaster—to strongly indicate its toughness—is said to grow readily under water or on a rock. I have no personal motives in writing thus of the Lancaster wheat; I only want to indicate that it is too tough fiber for the Hessian Fly to live on. It is nearly like or is the *Blue-stem wheat*.

Professor Cook ranks the *Clawson* as being less injured by the fly than the Lancaster, but I think the latter is absolutely free from the fly, while the *Clawson* is literally eaten up alive by the fly.

Mr. Devereaux afterwards wrote as follows, under date of October 29, 1879:

The Hessian Fly has not destroyed wheat to any great extent this year. However, all white wheat suffered from the attacks of the fly, but still not to the extent it did last year. Red wheat has never been attacked (*vide* my article in *Rural New Yorker*, June 15, 1878). The principal bearded red wheat sown in this locality is called the Lancaster. An amber wheat called Fultz (a bald wheat) seems to be proof against the fly. Mold's red wheat (bald) is also not attacked. But the *Clawson* (white), so extensively sown here and elsewhere, was most severely attacked in 1877, very badly in 1878, and this year it was thought to be free from the fly, but when harvest came it was noticeably short, many heads unfilled, many stunted in their height. At this date of writing every piece of *Clawson* sown this fall is being ravaged (however, there are only a few pieces of *Clawson* for miles around here), the Lancaster, as heretofore, remaining uninjured.

I notice after harvest long stubbles and straws of wheat in field and barn-yard which have many little pin-holes from which the imago *Cecidomyia* escaped. Barley was damaged to an enormous extent last year, whole fields having nearly every straw so badly damaged that they would break off readily by passing through with the horse-rake, throwing it into winrows. This year barley was not hurt much.

Now, wasn't the great spread of the Hessian Fly, which occurred many years ago, brought about at that time by that extensively sown wheat, the *Soules*, which was a very similar wheat to the *Clawson*, which brought the fly this time? Or rather, each kind of these wheats, by their tender foliage and loose culms, allowed the rapid propagation of the fly, being their favorite variety of wheat; we may also add the fact that these wheats were popular among the farmers everywhere; thus whole wheat districts were sown entirely to this wheat, bringing forth countless numbers of the Hessian Fly to every acre. In the former spread of the fly, farmers entirely desisted from raising wheat, or resorted to red or Mediterranean wheat, and so the pests can be driven back now to their less prosperous plants by the sowing of Lancaster and similar wheats.

In conclusion, we may urge that whatever kind of wheat is used, much more depends on a rich soil, a vigorous growth, and careful cultivation, all of which tend to make the stalk stouter, the growth a few days earlier, than the choice of particular varieties.

SPECIAL REMEDIES.

Under this head belong the use of lime, dusted on the young wheat, rolling, deep plowing, burning the stubble after harvest, &c. Such special remedies as these are of little use as compared with careful preparation of the ground and late sowing, and some of them actually do more harm than good, as we shall see further on.

Application of lime to kill the maggot or larvæ.—It has been frequently recommended to spread fine lime, soot, or salt upon the young wheat so as to kill the young larvæ. As a sample of such treatment, which at least can do no harm, we extract the following statement from the *Kansas Farmer*:

The farmer who recommends the remedy is a Virginian, and he writes to a local paper as follows:

"I hear there is much 'fly' in the wheat that was sown early this fall. To correct this evil I offer the following remedy, which I and others have successfully tested for a good many seasons: Sow of air-slacked or water-slacked lime one or two bushels per acre broadcast over the wheat in the early morning on the dew, or over night on a clear evening, when there is reason to expect dew or frost. As it dissolves it will form a lye which will follow the leaf towards the root and destroy the chrysalis of the fly near that point.

"The sower must always sow with the wind, else the lime will be blown back in his face and eyes and on his clothes. And he must grease his hands, face, and nostrils with lard, which renders contact with the lime innocuous. If two or more sow they should sow *en echelon*, at such a distance that the rear shall cast no lime on the front. A very good but not indispensable plan is to use tea scoops—diminutive sugar scoops—that will hold a double handfull. It enables one better to take up and measure the quantity to be applied. This is an application so simple and cheap as to discredit it with the many who are often looking to be told 'some great thing.' I can only say that I know it to be effectual as a remedy, and that in no case can it do harm."

It is evident that such remedies as these should be applied before the insect transforms into the flaxseed state, as the hard, dense pupa case is impervious to ordinary appliances such as would kill the maggots.

Rolling the ground to kill the larvæ and flaxseeds.—Practical men advise rolling the ground both to keep it moist and in order to destroy the eggs, larvæ, and some of the flaxseeds. This may be in some cases worth trying, but we should think that full as much injury would be done to the wheat plants as to the minute larvæ and eggs upon them.

Cutting the grain close to the ground.—This has been sometimes practiced. A writer in the *Ohio Farmer* makes the following statement in favor of this plan:

E. C. Green, Medina County, Ohio, writes: "The Hessian Fly appeared in this vicinity, but has done but little damage. The wheat commenced to fall over before it was cut, and the eggs or larvæ were found above the first or second joint. The damage on five acres of wheat was probably five or six bushels. By reaping low and raking the stubble was all saved."

A serious objection to reaping low is that many insects of the summer brood in the flaxseed state are, as Mr. S. S. Rathvon claims, carried to the barn or stack, beyond the reach of remedy. From the straw thus har-

vested the fly would emerge before it was threshed, "and might even pass through a machine without injury". In this manner the fly has possibly been distributed through different sections of the country.

Burning the stubble.—Although this remedy has been advocated, it will be seen to be worse than useless when we reflect that after all the artificial means taken to reduce the number of the Hessian Fly, nature's method of checking its undue increase is far more important and thorough-going; we refer to the diffusion and multiplication of the insect-parasites. As previously stated, most probably nine-tenths of the young Hessian Flies are destroyed in the larva or pupa state by the parasites already described. For the most part these parasites live in the flaxseeds contained in the straw, and appear in spring. Now, to burn the stubble in the autumn or early spring is simply to destroy these useful parasites, the best friends of the farmer. We do not hesitate to urge that the straw be untouched. On the contrary, the parasites should be gathered and bred in numbers; and we believe that practical entomologists should bend all their energies towards clearing up the subject of rearing and multiplying these insect hosts. Much knowledge and practical skill is needed in this direction, as occasionally by disseminating the parasites their noxious hosts may increase and be distributed; but knowing, as we do, how many more of the parasites are in many cases bred than the insects on which they prey, it seems safe and reasonable to advise not only not burning the stubble, but letting it stand, so that the parasites may finish their transformations, become fledged, and ready, when the eggs and larvæ of the Hessian Fly are upon or in the young wheat, to destroy them.

It is a matter of fact that in years when the Hessian Fly is specially abundant and destructive, similar seasons are highly favorable to the corresponding increase in the number of their insect or ichneumon parasites; they do their work so effectively that the few following years the numbers of Hessian Flies are greatly reduced. It is, then, to these parasites that we are indebted for the years of immunity from the attacks of the Hessian Fly, as much as to favorable or unfavorable weather, and this leads us to consider the apparent *periodicity* in the years of abundance and scarcity of the Hessian Fly.

PERIODICITY IN THE ABUNDANCE AND SCARCITY OF THE HESSIAN FLY.

The following tabular view, though constructed from very scanty and often misleading data, may throw some light on this subject. All insects, especially the more noxious ones, those which fall under common observation, such as the locust, cotton-worm, army worm, chinch-bug, and the like, have their years of undue numerical increase and of unusual scarcity. This periodicity is, without doubt, partly owing to the influence of the weather, of favorable and unfavorable seasons, and partly, in most cases,

to the absence or abundance of the insect parasites, although the latter cause is largely influenced by climatic agencies.

The table has been drawn up from the reports of Fitch, Hind, Cook, and of the Agricultural Department at Washington, and from different newspapers, as well as from private correspondence. The record, as therein presented, is very imperfect, but still is sufficient to show the periodicity in the return of periods when the Hessian Fly has been sufficiently abundant to ravage wheat-fields and excite apprehension and alarm. Without much doubt, in the different States mentioned, especially in the Middle States, the insect is tolerably abundant nearly every year, but few seasons occurring when after a careful search by experts the fly would not be found.

As the recorded facts indicate, within about ninety years there have been, in the Atlantic and Middle States, six periods of unusual abundance, namely, centering about the years 1790, 1817, 1844-'45, 1871-'72, and 1876-'78. These dates, which generally are inserted in larger type in the table, mark the time of culmination in the degree of abundance and extent of ravages committed, and were preceded by from one to several years of less or greater abundance. After the culmination, or year of greatest abundance, the fly often suddenly disappears. This sudden disappearance is, without doubt, due to the great increase in the number of parasites, while the original increase is probably due to a succession of warm, damp seasons, favorable to the multiplication of the flies. These seasons, when we look at the later Hessian Fly years, such as 1844-'45, 1871-'72, and 1876-'78, when the insect had become widespread over the western portion of the wheat area, were evidently areas of similar climatic features common to the Atlantic and Mississippi Valley States. Whether these seasons were warm and moist or not, we have not the means at hand to enable us to form an opinion. We simply at this time draw attention to the great desirability of putting on record the amount of correspondence between the meteorological conditions of the seasons of undue increase or unusual scarcity of insect pests, in order that we may be able in the future to make some calculations as to their probable increase or decrease, that farmers and gardeners may govern themselves accordingly.

As stated to us by Mr. Thomas, in 1817, the rainfall from Maine to Maryland was slightly above the average, 1.01 per cent. of the mean.

The winter of 1843-'44 was the most severe in the West that had been experienced for twenty years; the spring was cold and late; 1844 was very wet over the West, in fact the wettest season known since its settlement, or at least since 1811. This was the year of the great flood in the Mississippi. It was also wet in parts of Virginia and Maryland. But along the sea-coast from Maine to Florida the amount of rainfall was only about .90 per cent. of the mean. In 1845 it was not very wet in any section where wheat was cultivated, the amount along the sea-

coast being placed at .95, and this was about the same in the Middle and Northwestern States, varying from .83 to .91 per cent. of the mean.

We thus see that the Hessian-Fly years, 1817 and 1844, were wet years, periods of more than the average rainfall. Of 1871 we have no records at hand; the spring and summer of 1877 were damp and wet, and, also, appear to have been warmer than the previous year. There thus appears to be a correlation between the seasons of greatest abundance of Hessian Flies and a greater degree of moisture, if not of heat.

. 3 H F

DISTRIBUTION OF THE HESSIAN FLY.

There is little doubt but that this insect was, as stated first by Col. George Morgan, of Prospect, N. J., and afterwards by Mr. Herrick and Dr. Fitch, introduced from Europe. That it was originally a European insect is shown by Mr. Herrick,* who quotes a writer as authority for the statement that the insect was injurious to wheat near Geneva, in May, 1732, and again in May, 1755. It was also detected by Prof. J. D. Dana, in the spring of 1834, who found the larvæ, pupæ, and reared the flies from wheat growing on the island of Minorca. He sent several pupæ and flies from Mahon to Mr. Herrick, who identified them as the Hessian Fly. As he writes, "the Mahonese asserted that the insect had been there from time immemorial, and often did great damage both there and in Spain." Dana also collected the same insect at Naples, and also at Toulon, France. It seems, also, that this insect, or one very closely allied to it, injured the wheat in Hungary at or about the same date as Mr. Dana's visit to Europe, *i. e.*, 1834.

Like some other insects introduced from Europe, which there are only slightly injurious, the *Cecidomyia destructor* here became *prepotent*, *i. e.*, multiplied to an unusual degree, and became alarmingly prevalent, while in Europe it had not been even described by entomologists, its local ravages having been mostly confined to areas not visited, apparently, by entomological students.

With Herrick, Fitch, and others, we are disposed to credit the belief of Colonel Morgan, that this fly was introduced into America in the straw used for packing, brought by the Hessian troops during the Revolutionary war. These troops were landed on Staten and the west end of Long Island, August, 1776. This, then, was the starting-point from which the fly originated, and it will be interesting to learn how it spread to its present limits, how rapidly, and whether it is at all migratory. Our knowledge on these points will be mainly derived from Fitch's report and subsequent publications.

By reference to the foregoing chronological table of the years when the Hessian Fly was prevalent and injurious, one can comprehend easily the rapidity of distribution and the States successively invaded by it. The States are arranged as nearly as possible in the order in which they were first visited.

In his interesting history of the introduction of the fly into this coun-

* In the *Elements d'Agriculture*, par Duhamel du Monceau, Paris, 1771, 2 tomes, 12 mo., is a statement from M. de Châteauevieux, of which the following is a translation: "Our wheat [in the neighborhood of Geneva] has sustained, the present month of May, 1755, an injury from which the grain cultivated by the new husbandry has not been exempt. We found upon it a number of small white worms, which eventually turned to a chestnut color; they fix themselves within the leaves and gnaw the stalks; they are commonly found between the first joint and the root; the stalks on which they fasten grow no more; they become yellow and dry up. We suffered the same injury in 1732, when these insects appeared in the middle of May, and did such damage that the crops were almost annihilated," i, 299. The Hessian Fly and its parasites, by E. C. Herrick, *Amer. Jour. Sc.*, p. 153, 1841). The chestnut-colored worms mentioned by this writer are evidently the "daxseed" of the Hessian Fly, as no other wheat insect has such a pupa case.

try, Dr. Fitch shows that in August, 1776, Lord Howe's army, partly on Staten Island and partly at Flatbush, on Long Island, was strongly reinforced by Hessians and Waldeckers, most of whom were from Hesse Cassel, "a district but about a hundred miles distant from Saxe-Coburg and Saxe-Altenburg, where, as we have already seen, the same insect did much damage to the wheat crops in 1833." *

At Long Island, then, as shown by Dr. Fitch, the Hessian Fly originated, and from this point gradually spread over the wheat area of the colonies, and afterwards of the United States, enlarging its limits of distribution with the corresponding increase in the extent of the wheat area of our country.

It spread more rapidly at first towards the eastward, nearly to the end of Long Island and to Shelter Island. As Havens remarks, "It was first perceived a little before harvest, and appeared to have come from the west end of Long Island in a gradual progress of between twenty and thirty miles a year."

In ten years after its importation into America it reached Prospect, N. J., about forty miles southwest of Staten Island, and in 1788 it was noticed at Trenton, N. J., and in Pennsylvania. Undoubtedly, had there been railroads at that time, with the rapid transit of grain-cars and bales of hay and straw, it would have spread at least with three times the rapidity of its recorded rate of diffusion.

In 1789 the fly first reached Saratoga, a point situated 200 miles north of its original point of departure. "The insect reached here by a regular progress from the south, coming nearer and nearer each successive year."

It appeared west of the Alleghanies in 1797, though in what state we are unable to learn, while Virginia was invaded in 1801, and North Carolina about the year 1840. Westward its progress brought it to Ohio in 1840, and three years later it was detected in Michigan. In 1844 it was destructive in Ohio, Indiana, Illinois, Michigan, Wisconsin, and the eastern border of Iowa, while it was common in the Middle Atlantic States, and became destructive in Northern Georgia in 1845. Meanwhile it had reached Western Canada in 1805. North of Connecticut it seems to have existed only sporadically, and to have maintained only a temporary foothold in Vermont and Maine in 1850-'52, and has never been noticed in New Hampshire or in Massachusetts. Minnesota was visited in 1860, and probably earlier.

It must have reached Missouri, Arkansas, and Texas long previous to the date given in our table, but probably the year it entered Eastern

* Sir Joseph Banks drew up a report on this insect for the Privy Council, dated March 12, 1789. He states that "since its first appearance in Long Island it has advanced at the rate of fifteen or twenty miles a year, and neither waters nor mountains have impeded its progress. It was seen crossing the Delaware like a cloud from the Falls Township to Wakefield; had reached Saratoga, 200 miles from its first appearance, infesting the counties of Middlesex, Somerset, Huntington, Morris, Sussex, the neighborhood of Philadelphia, all the wheat counties of Connecticut, &c., committing the most dreadful ravages, attacking wheat, rye, barley, and timothy grass. The Americans who have suffered by this insect speak of it in terms of the greatest horror."—Dobson's Encyclopedia, viii, art. Hessian Fly.

Kansas (1871-'72) is not much posterior to its arrival there, and this is at present its most westernmost limit. No traces of it, so far as we can learn, have been seen in Nebraska. (Compare the map at the end.)

Does the Hessian Fly migrate?—As regards the so-called migrations of this insect, we would express our disbelief in any such movement from place to place as is involved in the idea of the word migration. The history of the insect simply shows that it has steadily spread from its original point of introduction to new sections of the country as rapidly as they were settled and wheat became a staple article of production. It is periodically abundant, much as most other obnoxious insects are, more abundant some years than others; becoming abundant at some localities and scarce at others. It cannot, therefore, truly be said to "migrate" from one part of a State to another, or from one natural region to another.

Probable limits of the Hessian Fly.—The question naturally arises whether this pest will ever infest the wheat regions of Western Dakota, Montana, Utah, Colorado, and the Pacific States and Territories. We believe not, though aware that such a statement may be hazardous. It was originally an inhabitant of Central and Southern Europe; it has become acclimated in the Eastern Atlantic and Middle States, in the valley of the Upper Saint Lawrence, and in the valley of the Mississippi River; that it can thrive in the elevated, dry Rocky Mountain plateau region, and withstand the cool nights and dry, hot atmosphere of the Far West, seems very doubtful. At least, so slowly has it spread westward, so slight an amount of wheat or straw is transported westward, all produce of this kind going eastward, that we doubt whether, during this century at least, it will extend west of Kansas and Minnesota, where it has already had a foothold for several years.

SUMMARY OF THE HABITS OF AND REMEDIES AGAINST THE HESSIAN FLY.

1. There are two broods of the fly, the first laying their eggs on the leaves of the young wheat from early April till the end of May, the time varying with the latitude and weather; the second brood appearing during August and the early part of September, and laying about thirty eggs on the leaves of the young winter wheat.

2. The eggs hatch in about four days after they are laid. Several of the maggots or larvæ make their way down to the sheathing base of the leaf, and remain between the base of the leaves and the stem near the roots, causing the stalk to swell and the plant to turn yellow and die. By the end of November, or from thirty to forty days after the wheat is sown, they assume the "flaxseed" state, and may, on removing the lower leaves, be found as little brown, oval, cylindrical, smooth bodies, a little smaller than grains of rice. They remain in the wheat until during warm weather; in April the larva rapidly transforms into the pupa within its flaxseed skin, the fly emerging from the flaxseed case about

the end of April. The eggs laid by this first or spring brood of flies soon hatch; the second brood of maggots live but a few weeks, the flaxseed state is soon undergone, and the autumn or second brood of flies appear in August. (In some cases there may be two autumn broods, the earliest August brood giving rise to a third set of flies in September.)

3. There are several destructive ichneumon parasites of the Hessian Fly, whose combined attacks are supposed at times to destroy about nine-tenths of all the flies hatched. Of these, the most important is the Chalcid four-winged fly (*Semiotellus destructor*, Plate 1, fig. i, much enlarged), which infests the flaxseed; and the egg-parasite (*Platygaster*, fig. 1).

4. By sowing a part of the wheat early, and if affected by the fly, plowing and sowing the rest after September 20, the wheat crop may in most cases be saved. It should be remembered that the *first* brood should be thus circumvented or destroyed in order that a second, or spring, brood may not appear.

5. If the wheat be only partially affected, it may be saved by fertilizers and careful cultivation; or a badly damaged field of winter wheat may thus be recuperated in the spring.

6. Pasturing with sheep, and consequent close cropping of the winter wheat in November and early December, may cause many of the eggs, larvæ, and flaxseeds to be destroyed; also, rolling the ground may have nearly the same effect.

7. Sowing hardy varieties. The Underhill Mediterranean wheat, and especially the Lancaster variety, which tillers vigorously, should be sown in preference to the slighter, less vigorous kinds in a region much infested by the fly. The early (August) sown wheat might be Diehl; the late sown, Lancaster or Clawson.

8. Of special remedies, the use of lime, soot, or salt may be recommended, also raking off the stubble; but too close cutting of the wheat and burning the stubble are of doubtful use, as this destroys the useful parasites as well as the flies.

FURTHER INFORMATION DESIRED.

What has been stated in the foregoing pages has been mostly compiled from the observations of others, though all the members of the commission have paid more or less attention to this pest in former years.

In order that a more detailed, valuable report may be made as to the habits, distribution, remedies, and statistics of losses, all necessary for a full and satisfactory treatment of the subject, answers to the following topics from wheat-growers in the United States, especially in the South and West, are earnestly desired. The publications of the commission will be sent free to all persons who will kindly send replies and specimens to the following questions; and postage and all necessary expenses will be paid to those sending specimens of this or any other insects in-

festing wheat, barley, oats, and rye. The writer may be addressed at Providence, R. I.

1. At what date is the "flaxseed" state of the Hessian Fly assumed?
2. At what date does the fly appear in spring and autumn?
3. During what year did the Hessian Fly first appear to do damage in your neighborhood, and how was it introduced?
4. How many "broods" or generations are observed annually—more than two? and when does the plant suffer most, in spring or autumn?
5. State what you know of the relative immunity or susceptibility of different varieties of wheat, and upon what other cereals or grasses the insect is known to develop.
6. What kind of weather favors its injuries, and what meteorological conditions prevent them? Was the season of greatest abundance a wet or dry one?
7. Look for minute parasites in the eggs and maggots and flaxseed. They may be bred by placing the eggs and maggots with the wheat in bottles covered with paper, or even loosely corked, and the parasitic flies preserved in vials of alcohol.
8. Give statistics as to abundance and losses in your town or county.
9. State the best preventive remedies, as high culture, the rotation of crops, pasturing to sheep or cattle, rolling, &c.

Specimens of the wheat affected by these insects, and of the eggs, maggots, and flies, together with their parasites, in alcohol, are requested. When mailed, the alcohol can be poured out, and cotton soaked in alcohol will keep the specimens wet until received. Packed in a tin box they can be sent through the mail.

APPENDIX.

LIST OF WORKS AND ARTICLES RELATING TO THE HESSIAN FLY.

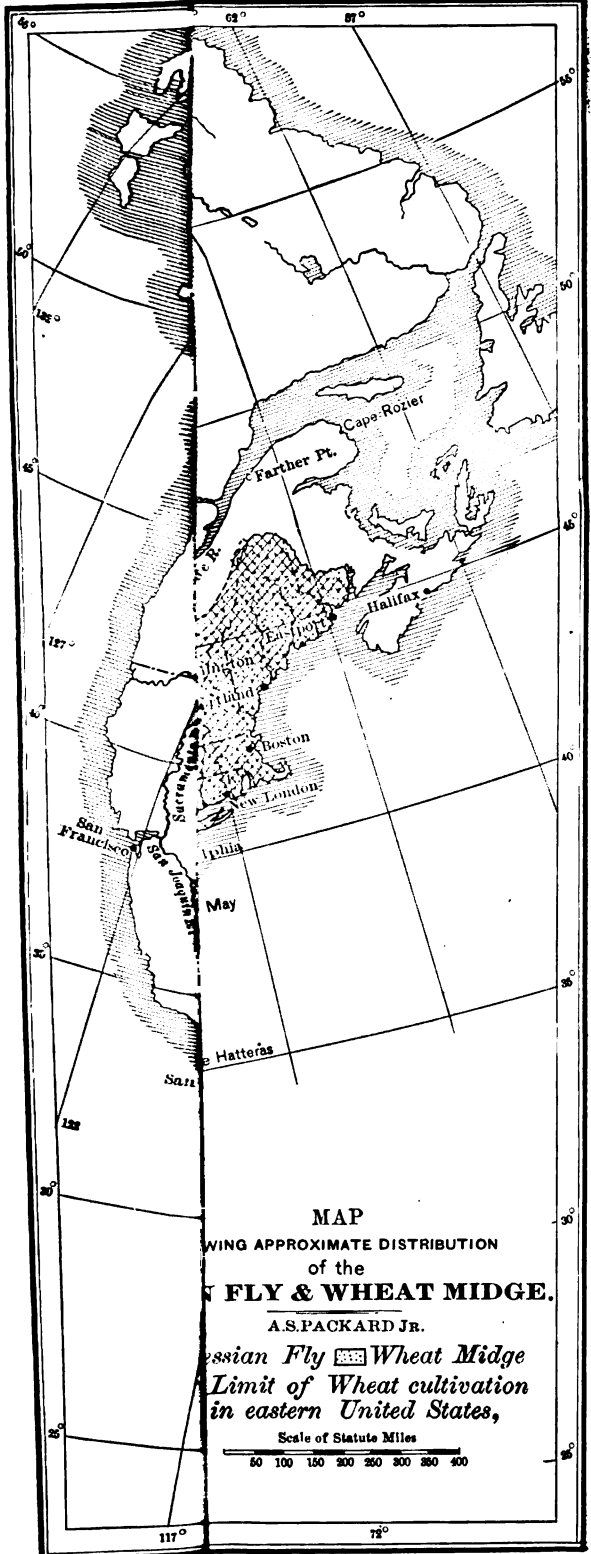
The following list embraces the most important writings relating to the Hessian Fly. The title of many of them are taken from Fitch's report and the bibliographical list in Bergenstamm and Loew's *Synopsis Cecidomyidarum*.

- DUHAMEL. *Éléments d'Agriculture*. Par Duhamel du Monceau. Paris, 1771, i, p. 229.
- MORGAN, GEORGE. *Pennsylvania Mercury*, June 8, Sept. 14, 1787.
- CLARK, THOMAS. *Pennsylvania Mercury*, Sept. 14, 1787.
- VACX and JACOBS. *Philadelphia Packet*, Aug. 21, 1788.
- HAVENS. Observations on the Hessian Fly. By Jonathan N. Havens. *Transactions of the New York Society for the Promotion of Agriculture, Arts, and Manufactures*, 1792. Second edition 1801, pp. 71-86.
- CHAPMAN, Dr. ISAAC. *Memoirs of the Philadelphia Society for Promoting Agriculture*, v, 1797.
- ENCYCLOPÆDIA BRITANNICA, viii. Article Hessian Fly, pp. 489-495, 1797.
- DONSON. *Encyclopædia; or a Dictionary of Arts and Sciences and Miscellaneous Literature*. Article Hessian Fly. Published by Thomas Dobson. 21 vols. Philadelphia, 1798-1803. viii, p. 489-495, 1798.
- MITCHELL. *Encyclopædia Britannica*. Address in. *Transactions of the New York Society of Agriculture*, i, p. 32. Article in *Medical Repository*, vii, p. 97, 1803.
- ANONYMOUS. *Carey's American Museum*, Phila., i, pp. 143, 324-326, 1786; iv, p. 47, 1788; xi, pp. 285, 301, 1792.
- MCLELLAN. Article in *American Farmer*, by H. McLellan, ii, p. 234, 1804.
- KIRBY and SPENCE. *An Introduction to Entomology*. By W. Kirby and W. Spence. 1815-'26, i, p. 50.
- BOSC. Quelques aperçus sur l'insecte connu sous le nom de Mouche Hessoise, et sur un insecte parasite qui s'en nourrit. Par L. A. G. Bosc d'Antic. *Annales de l'Agricult. France*. Tom. 70, 1817, pp. 277-303.
- SAY. Some account of the insect known by the name of Hessian Fly, and of a parasitic insect that feeds on it. By Thomas Say. *Journal of the Academy of Natural Sciences*, i, pp. 45-48, with a plate, 1817. See also *Magazine of Natural History*, vol. i. (Kirby).
- ANONYMOUS. An account of the wheat insect of America, or the *Tipula vaginalis tritici*, commonly called the Hessian Fly, *American Monthly Magazine and Critical Review*, August, 1817, New York, i, pp. 275-279.
- COCKE. Address by John H. Cocke to Albemarle Agricultural Society of Virginia, 1817.
- MERRIWEATHER. Articles, by Dr. Merriweather and others, in the *Richmond Inquirer*, *National Intelligencer*, and *American Farmer*, 1817 *et seq.*
- GARNETT. Article by James M. Garnett in the *American Farmer*, ii, p. 174, 1820.
- TILGHMAN. Article by Edward Tilghman in the *American Farmer*, ii, p. 235, 1820. Also in *Cultivator*, viii, p. 82, May, 1841.
- WORTH. Article by James Worth in *American Farmer*, ii, p. 180, 1820.
- HICKOK. Essay by Judge Hickok in *Memoirs of the New York Board of Agriculture*, pp. 169-171, 1823.
- BIRNIE. On the efficacy of certain steps to preserve wheat from the fly and smut (Hessian Fly). By C. Birnie. *New England Farmer*, iii, p. 171, 1824.
- BUEL. Paper by Judge Buel in the *Memoirs of the New York Board of Agriculture*, iii, pp. 325-338, 1825.
- WESTWOOD. Article *Cecidomyia*, by J. O. Westwood, in *British Cyclopædia of Natural History*.
- KOLLAR. *Naturgeschichte der schädlichen Insecten in Bezug auf Landwirthschaft und Forstkultur*. Wien, 1837. English translation by J. and M. London, with notes by J. O. Westwood. London, 1840, pp. 118-123.
- MORRIS. On the *Cecidomyia destructor*, or Hessian Fly. By Margaretta H. Morris. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1841, pp. 68-68; iii, 1847, p. 238; iv, 1849, p. 134. *Transactions of the American Phil. Society of Philadelphia*, ser. 2, viii, 1843, pp. 40-51.

- COATES. Remarks on the Present State of the Evidence in Regard to the Hessian Fly. By Benjamin H. Coates, M. D. 1841.
- . Note on the natural alliances of the genus *Cecidomyia*, intended to facilitate identification. By B. H. Coates. *Proceedings Acad. Nat. Sci. Phila.* 1842, i, pp. 191-192.
- . On some larvæ in wheat stalks. By B. H. Coates. *Proceedings Acad. Nat. Sci. Phila.*, 1842, i, pp. 45, 54-57.
- BERGEN. Remarks on the Hessian Fly. By Garret Bergen. *Cultivator*, viii, Albany, Aug., 1841.
- HERRICK. A brief preliminary account of the Hessian Fly and its parasites. By Edward C. Herrick. *American Journal of Science and Arts*, xli, Oct., 1841, New Haven, pp. 153-158.
- . Observations on the Hessian Fly. By E. C. Herrick. Report of the Commissioner of Patents for 1844, Washington, 1845, Appendix, pp. 161-167. See also letters to Dr. T. W. Harris in entomological correspondence of T. W. Harris, and the *Connecticut Farmers' Gazette*, No. 40.
- HARRIS. A Report on the Insects of Massachusetts Injurious to Vegetation. By Thaddeus W. Harris. Cambridge, 1841, pp. 421-433. Reprint, 1842. Second edition, Boston, 1852. Third edition, with illustrations, 1862.
- . Article by T. W. Harris in *New England Farmer*, 1842, xx, pp. 409-410.
- . Entomological Correspondence of Thaddeus William Harris, M. D. Edited by Samuel H. Scudder. *Occasional Papers of the Boston Society of Natural History*, i, Boston, 1869, 8°, pp. 181-207.
- CURTIS. Observations, etc., including a saw fly, the Hessian Fly, the wheat midge, and the barley midge. By John Curtis. *Journal of the Royal Agricultural Society of England*, 1845, vi, pp. 131-156, pl. 1. Separately printed, London, 1845, 8°, p. 28, pl. 1.
- . *Farm Insects*. By John Curtis. London, 1860, p. 258.
- WESTWOOD. Article on the Hessian Fly. By John O. Westwood. *Gardeners' Chronicle*, London, 1847, p. 604.
- YUKES. Notice by J. D. Yukes. Patent Office Report, Washington, 1850.
- FITCH. The Hessian Fly; its history, character, transformations, and habits. By Asa Fitch, M. D. [originally published in the *American Journal of Agriculture and Science*, iv, v, 1845, and now revised by the author]. *Transactions of the New York State Agricultural Society*, vi, 1846, Albany; 1847, 8°, pp. 316-373, with a plate. Printed separately, Albany, 1846, 8°, p. 63, with a plate; and also Albany, 1847, 8°, p. 60, with a plate.
- . Seventh report on the noxious and other insects of the State of New York. By Asa Fitch, M. D. pp. 133-144, with a plate, 1862.
- MOTSCHULSKY. Article by Victor Motschulsky in *Journal du Ministère de l'Intérieur*, 1852.
- HIND. Essay on the Insects and Diseases Injurious to the Wheat Crops. By H. Y. Hind, Toronto, 1857, pp. 38-74.
- SICHEL. Article by Jules Sichel in *Annales des Société Entomologique de France*, 1856, iv, Bulletin, p. 8.
- LOEW. Ueber die den Roggen in den Prov. Schlesien und Posen vernüftende Fliegenmade. By H. Loew, in *Zeitschrift Entomol. schles. Verein für Insektenkunde*, 1858, xii.
- . Die neue Kornmade und die Mittel, welche gegen sie anzuwenden sind. *Zullichan. Sporleder*, 1859, 8°, p. 29.
- OSTEN SACKEN. Article by R. Von Osten Sacken in *Stettin entomologische Zeitung*, 1862, p. 80.
- HABERLANDT. Article by Haberlandt. *Verhandlungen zool.-botan. Gesellschaft*, Wien, 1854, p. 401.
- KÜNSTLER. Article by Künstler. *Verhandlungen zool.-botan.-Gesellschaft*. Wien, 1864, pp. 407, 779; 1871, p. 15.
- WALSH. Brief notices by B. D. Walsh, editor of the *Practical Entomologist*, 1867, pp. 10, 37.
- STIERLIN. Article by Stierlin in *Mittheilungen der Schweiz. entomol. Gesellschaft*, 1868, ii, p. 157.
- COHN. Untersuchungen über Insectenschaden auf den schlesischen Getreidefeldern im Sommer 1839, 1839, p. 12.
- KALTENBACH. Die Pflanzenfunde aus der Klasse der Insekten. Stuttgart, 1874, pp. 734, 738, 741.
- RUDOW. Die Pflanzengallen Norddeutschlands und ihrer Erzeuger. 1875, p. 84.
- BERGENSTAMM and LOEW. Synopsis *Cecidomyidarum*. Von J. E. von Bergenstamm und Paul Loew. Aus den Verhandlungen der K. K. zoologisch-botanischen Gesellschaft in Wien, 1876, 8°, p. 104.
- PACKARD. Guide to the Study of Insects. By A. S. Packard, jr., M. D. 8°, first edition, 1868-69, pp. 374-375, Salem, Mass. Second edition, 1870. Third edition

1872. Fourth edition, 1874. Fifth edition, 1876. Sixth edition, New York, 1878. Seventh edition, New York, 1880.
- . *Our Common Insects*. Salem and Boston, 1873, 12°, pp. 79, 196.
- . *Half Hours with Insects*. Boston, 1877, 12°, pp. 212-215.
- . *Report on the Rocky Mountain Locust and other Insects now injuring or likely to Injure Field and Garden Crops in the Western States and Territories*. By A. S. Packard, jr., M. D. (Published in Report of the United States Geological Survey of the Territories, F. V. Hayden in charge, 1875.) Washington, 1877, pp. 695-697. Fifty extra copies with a separate title page. *The Injurious Insects of the West*. Salem, S. E. Cassino, 1877, 8°, pp. 589-815, this being the original pagination, with a map showing the distribution of the Hessian Fly.
- COOK. *The Hessian Fly*. A lecture by Prof. A. J. Cook. Michigan, 1878, 8°, p. 14.
- RILEY. Report of the Entomologist Charles V. Riley, M. A., Ph. D., August 22, 1879. (Author's edition, from the Annual Report of the Department of Agriculture for the year 1878.) Washington, 1879.
- . *Hessian Fly and Wheat Rust*. New York Weekly Tribune, Dec. 19, 1877.
- . *Fighting the Hessian Fly*. New York Weekly Tribune, Sept. 12, 1877.
- . *The Hessian Fly*. Saint Louis Illustrated Journal of Agriculture, June 14, 1877.
- HAGEN. *The probable Parthenogenesis of Cecidomyia destructor*. By Dr. H. Hagen, North American Entomologist, vol. 1, No. 9, March, 1880, p. 65, 66. (Noticed in American Entomologist, iii, p. 127.)



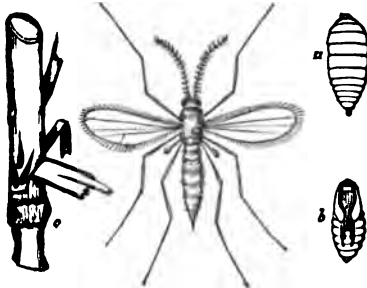


DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 4.

THE HESSIAN FLY,

ITS RAVAGES, HABITS, ENEMIES, AND MEANS OF
PREVENTING ITS INCREASE.



By A. S. PACKARD, Jr., M. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1880.

MEMBERS OF THE COMMISSION.

CHARLES V. RILEY, *Chief*,
Washington, D. C.

A. S. PACKARD, JR., *Secretary*,
Providence, R. I.

CYRUS THOMAS, *Disbursing Agent*,
Carbondale, Ill.

THE HESSIAN FLY:

ITS RAVAGES, HABITS, AND MEANS OF PREVENTING ITS INCREASE.

INTRODUCTION.

Next to the Rocky Mountain Locust, the Cotton Worm, and Chinch Bug, the Hessian Fly is at present the most destructive of our noxious insects. It attacks wheat, our most important agricultural product, and at times has been so abundant as to cause farmers to abandon the culture of this grain over large sections of the Union. While the fly has been well known and destructive for about a century, the vast extension within a decade of years of the wheat-growing area of the West, and the corresponding prevalence of the fly in the Northwestern States, together with its wide-spread destructiveness, has given fresh interest and importance to this pest. Moreover, the cultivation of wheat in the New England States, where about twenty years ago it was abandoned on account of the ravages of this fly and the wheat midge, has been resumed in part, so that the dissemination over the wheat area of the United States of the known facts in regard to its habits and modes of doing injury seems necessary. This area, as seen in part by the map* appended to this Bulletin, which has been compiled from Walker's Statistical Atlas, embraces all of the United States north of the 35th parallel of latitude and east of the 93d meridian, with the addition of tracts in Dakota, Montana, Colorado, New Mexico, and Utah, as well as in California, Oregon, and Washington Territory. These last-named wheat areas were not mapped by General Walker, and have been omitted on the present map, since the Hessian Fly is not known to exist west of Eastern Kansas.

Though the habits of the Hessian Fly are tolerably well known, much additional knowledge is desirable regarding its distribution, its breeding habits, and its parasites, while in order to properly apply the best preventive remedies, to stamp out the pest as it appears in new wheat sections, we need the results of a larger number of experiments as to the effects of early and late sowing, what varieties of wheat to sow, and as to the value of manures and artificial fertilizers in promoting the rapid and healthy growth of the young wheat, by which it may outgrow the weakening effects of the worm and ripen its grain.

The object of this Bulletin is not so much to convey new information to wheat-growers as to briefly state what thus far is known as to the appearance, ravages, habits, and remedies against its attacks. By widely disseminating this knowledge, seeking fresh facts from practical farmers all over the country, who are hereby asked to send to the author all new facts and results of valuable experiments, it is hoped and believed that

* Taken from a report on the Rocky Mountain Locust and other insects now injuring, or likely to injure, field and garden crops in the Western States and Territories. By A. S. Packard, Jr. From the Report for 1875 of Hayden's United States Geological Survey of the Territories.

the Commission will be able in a future report, after another season's work in the field, to throw further light on the subject.

Although this pamphlet has been prepared by but one member of the Commission, the writer is indebted to Prof. C. V. Riley for drawings, specimens, and data; to Professor Thomas for facts and suggestions; and would also acknowledge aid received from Prof. A. J. Cook, of the State Agricultural College, Lansing, Mich., whose address on the Hessian Fly has been of much service and liberally quoted in this Bulletin, and also from the correspondents and agricultural papers mentioned here and there in the following pages.

LOSSES OCCASIONED BY THE HESSIAN FLY.

This fly first became a serious pest in the country in the year 1779, although, as will be seen further on in the section on the distribution of the insect, it probably began its work of destruction on Staten Island and Long Island in 1776. According to Fitch, 1779 was probably the date when its ravages actually began. "The crops of wheat were severely injured or wholly destroyed by it in King and Richmond Counties during several of the following years, and each succeeding generation regularly enlarged the sphere of its devastations in every direction."

In 1781 the fly almost totally destroyed the wheat crop in Eastern Long Island, and in 1786 the crops were either totally or partially destroyed in New Jersey in and about Prospect, an area situated forty miles southwest of Staten Island. In 1786 and 1787 the ravages of this pest attracted much attention in New York and Pennsylvania; the wheat crop on Eastern Long Island having been "cut off almost universally." About Trenton, N. J., in 1788, the wheat crop was in many cases a total failure. As wheat in large quantities was at this period exported to Great Britain, "accounts of the appalling havoc that this insect was making excited the attention of the government there and aroused their fears lest so dreadful a scourge should be introduced into that country by means of the American grain." (Fitch.) As a result, the exportation of grain from America was prohibited until the English Government was assured that the fly with eggs could not be introduced in the grain. As long since as 1800, Dr. S. L. Mitchell, of New York, affirmed that "the insect is more formidable to us than would be an army of twenty thousand Hessians." (Herrick.)

Between 1789 and 1803 severe losses ensued from its attacks in Saratoga and Washington Counties, New York; "on two or three occasions many of the fields in Saratoga were entirely destroyed."

In 1804 President Dwight, of Yale College, remarked that "this insect is feeble and helpless in the extreme, defenseless against the least enemy, and crushed by the most delicate touch; yet for many years it has taxed this country annually more, perhaps, than a million of dollars." (Herrick.)

In 1803 and 1804, in the neighborhood of Richmond, Va., "they swept whole fields." In 1817 it "renewed its ravages in various sections of

the country; was unusually abundant," and "in parts of Maryland and Virginia it was perhaps more destructive than it had ever been before."

At what year the Hessian Fly first occurred in the New England States is uncertain; so far as we can ascertain it was first noticed at New Haven, Conn., in 1833, by Mr. Herrick, a careful entomologist, but without doubt it was introduced from New York early in the century.

In Lower Canada it was, according to Hind,* between 1805 and 1816, "prevalent and destructive in some parts," but in 1830-'36 it disappeared in Lower Canada.

The fly first appeared in 1837 at Paw Paw, Mich., in the second crop sown in Van Buren County; none had been raised at a point nearer than twelve miles. (D. Woodman.)

The Hessian Fly has been known in Person County, North Carolina, for fifty years; and another correspondent writes us from Goldsborough, N. C., that—

Previous to the period, say 1840, our farmers had been accustomed to sow wheat as early as September, but a fly, called by them the "Hessian Fly," so depredated that they deferred sowing to the latter part of November, and now, generally, to "between the Christmases" (new and old Christmas); their crop is now unmolested by the Hessian or any other fly.

The losses in Pennsylvania in 1842 were heavy, the wheat crop of the State being estimated at 20 per cent. less than in the preceding year, the fly being the principal cause of the loss. At this year Ohio was visited by it, when "it appeared to be increasing so much that serious apprehensions were beginning to be felt respecting its future ravages." (Fitch.)

Great havoc in many fields in Maryland and Virginia was committed by it in 1843. In the following year it did much injury in Northern Indiana and Illinois and the contiguous parts of Michigan and Wisconsin, in many places occasioning "almost a total failure of the crops." In Michigan the wheat crop was almost an entire failure. On Long Island, at Rochester, N. Y., and throughout Pennsylvania the losses this year were severe; the following year it did more or less injury all over the State of Illinois, while in the central parts of Maryland the crops, in many instances, were rendered totally worthless. "In Georgia, moreover, its ravages in the counties around Milledgeville are said to have been dreadful; whole fields were totally destroyed, and others yielded not more than a fourth of an ordinary crop."

In 1846, in the upper counties of Georgia, it was said "the fly has committed such ravages upon the wheat as scarcely to leave enough seed for another year." Throughout the State of New York it was destructive this year; in the western section the loss from this insect was estimated at not less than 500,000 bushels. In Maryland this same year (1846), as recorded by Fitch, "so great ravages have not been committed by the Hessian Fly since 1817. On some of the best land wheat has

*Essay on Insects and Diseases injurious to the Wheat Crops, by H. Y. Hind, Toronto, Canada, 1857, 8^o, p. 133.

been plowed up, and other portions are so much injured that they will not be worth harvesting. At least one-half of the crop of Talbot County has been destroyed." And in the upper counties of Georgia it is said "the fly has committed such ravages upon the wheat as scarcely to leave enough seed for another year."

In 1847 the losses were generally widespread but light, while in 1849 it was destructive in some of the counties in New York, and especially in Ohio. From this date until 1853 it was not destructive, but this year it "committed great ravages in some parts of Pennsylvania." In 1854 it was destructive in Aroostook County, Maine, as well as in Michigan.

From 1855 to 1860 the Hessian Fly attracted little attention from the agricultural community. In 1860 the fly "had reached as far west as Iowa and Minnesota, and in 1863 the wheat-fields along the Detroit and Milwaukee Railroad promised nothing because of the ravages of this pest." (Professor Cook.)* In 1866 it is reported to have occurred in Maryland, Delaware, and Ohio, and in 1868, according to a writer in the *American Entomologist*, about Fond du Lac, Wis., "much of the wheat crop was damaged by it."

In 1871 it was generally prevalent throughout the Middle States from South and North Carolina and Virginia to Missouri northward; also occurring in Kansas, Georgia, and Minnesota, and in 1872 and 1873 was destructive and widespread in Maryland, Ohio, Indiana, Illinois, and Eastern as well as Western Virginia, as well as in Michigan, "as also in the States south and west" of the last-named commonwealth.

In 1874 it was widespread, but much less destructive; in 1875 and 1876 it was especially destructive in Missouri, Pennsylvania, and Virginia. In 1876 "it appeared in force in many of the southern counties of Michigan, reaching as far north as Mason, in Ingham County, causing much destruction." (Professor Cook.)

In 1877 the losses again became heavy over a large part of the wheat area. At Lawrence, Kans., the early-sown wheat "suffered a good deal from the ravages of the Hessian Fly." At Gardner, Kans., all early-sown wheat "was full" of the "flaxseed" of the Hessian Fly. At Saint Genevieve, Mo., the fly was "much worse than for years past." At Independence, Mo., the crop in some fields was nearly a failure. In Henderson County, Kentucky, while prevalent, only one wheat-field was "badly damaged"; while in Vanderburgh County, Indiana, "many fields were infected." In Central Illinois a correspondent of the *Cultivator and Country Gentleman* states that "the Hessian Fly has been present in the lower portion of the winter-wheat region for several years," and in 1877 "it appears that the Hessian Fly is generally present in greater or less numbers over the whole winter-wheat region; that in almost every case it has attacked and done more or less damage to early-sown wheat-fields."

* In his seventh report, written apparently in 1862, Dr. Fitch remarks: "We hear of it at the present time as very destructive in Illinois and some of the contiguous States, the crop in many wheat-fields being totally ruined by it."

In Michigan the fly, while troublesome in 1876 was also very generally so in the succeeding year, as stated by Professor Cook, as follows:

This year, 1877, we hear of it as more broadly distributed in our State, while complaints come to our ears from Ohio, Indiana, Illinois, New York, and Pennsylvania. Since writing the above, I have passed through our State and also the State of Ohio, on two of the different trunk lines of railroads, and I find that all through Southern Michigan and all of Ohio, at least north of the latitude of Columbus and Dayton, this insect abounds in force.*

The following extracts from Michigan papers show the situation in that State this year:

Farmers are complaining of the ravages of the "fly" in their wheat-fields. Much damage is reported.—*Jonesville Independent*.

Mr. James Taylor showed some wheat-stalks from his farm to-day which had over forty insects in one stalk.—*Kalamazoo Gazette*.

Wheat heading out ten days to two weeks earlier than usual this year, and doubtless much of it will be ready to cut in June.—*Portland Observer*.

The "fly" or "insect," as called by the farmers, is playing sad havoc with the wheat crop in this county. Not over half a crop will be realized.—*Kalamazoo Gazette*.

The fly is very seriously injuring the wheat in Porter. One of the largest farmers in that township yesterday told us that a few weeks ago he would not have taken 3,000 bushels for his crop, but now he would gladly take 1,000.—*Paw Paw Courier*.

Much complaint is now heard from all sides in regard to the work of the insects in early-sown wheat. The dry weather has so far retarded the growth as to give the pests the power to destroy. There is little question that early-sown wheat is suffering greatly.—*Marshall Expounder*.

Farmers from all over the county come to town looking doleful enough. The wheat crop promises to be almost a total failure. Two weeks ago everybody was happy over the prospects of an abundant harvest, but now flies, worms, and drought seem to have ruined the crop and blighted every home.—*Marshall Statesman*.

Farmers from all the adjoining towns complain that their growing wheat crops are badly injured by the insects. Wheat-fields which promised a heavy yield two weeks ago, it is thought, will not produce over a half a crop, and many fields are reported as already nearly destroyed. Naturally some allowance should be made for the apprehensions of those whose fields are thus ravaged; but there is no doubt that the crop through this section is materially damaged by these destructive pests.—*Battle Creek Journal*.

Mr. T. F. Miller, of Richland, brought into our office Monday morning a handful of wheat (taken from a farm on the prairie) that is literally alive with the insect. He says that in his opinion nearly every field in Richland is so badly affected that there cannot be half or even a third of a crop. The dry weather has stopped the growth, and the wheat is more affected on that account. We hear the same report from other parts of the county. Grain is also suffering for want of rain.—*Kalamazoo Gazette*.

The following extract from the *New York Cultivator and Country Gentleman* will give the condition of affairs in West Virginia:

Since reading your article making known Mr. A. S. Packard's request, in the issue of November 15, I have had occasion to make a business trip through Hardy, Hampshire, Mineral, and Grant Counties, and find upon examination that there is not a single field which is not more or less damaged by the fly. The early-sown wheat, having luxuriant growth, does not seem to be entirely destroyed, but has the appearance of mixed yellow and green. I find, upon close examination, it is filled with the fly. Other fields, sown after corn-cutting, show a greater amount of damage; one in particular, a limestone upland, was scarcely tinted with green, the fly having already

* The Hessian Fly. A lecture by Prof. A. J. Cook, of the Michigan State Agricultural College, delivered at Farmer's Institute held at Paw Paw and Climax, Mich., 1878, 8vo., p. 14. Digitized by Google

consumed nearly the whole of it. My course from this point was north and west. I find that the farther north I travel the more damaged is the wheat. In this (Hardy) county the damage, so far, appears not to be material. Some crops of early-sown wheat were considerably shortened last year, the first year in many that we have felt the effects of the fly. One farmer, whose wheat seemed already a failure, asked me what he should do. I advised when the land was dry, or hard frozen, to put all the sheep he could get upon it, and keep them there until they had eaten it off as close as a sheep could nip, as the only remedy. I thought that the sheep could do no worse than what must be eventually done by the fly, and it might save the crop. He asked me if I thought the insect would be "wholesome for the sheep." This I could not answer, and refer the query to you.—R. M. W., Moorefield, W. Va.

A correspondent of the same paper thus records the injury done by this insect about Syracuse, N. Y.:

Wheat sown early, from the 1st to the 20th of September, has made an extraordinary growth. The fine weather was favorable; besides more care has been paid to good culture than before. The seed also has been selected, cleaned, and graded with greater care, showing much progress. From appearances now, it will result in a loss. Whole fields, and parts of others, are turning yellow, showing the ravages of the fly to a larger extent than I ever before witnessed. It begun to turn yellow on knolls, or where the plaster rock came near the surface, and was thought only the effect of dry weather, but now it has extended all over early-sowed fields. Should the warm weather continue, great injury will result to the entire crop, as it has been sown much earlier than usual and has looked remarkably fair. Later sowing, with a greater breadth of spring wheat, is the only remedy now offered. Will other parties in different sections make an examination and send notes?—C., Syracuse, N. Y.

While, so far as we have been able to learn, no serious damage, if any, has been done to wheat in New England by this pest since 1854, in Western Canada it again became abundant in 1874, but most injurious in 1876 and 1877. In 1876 it appeared in great force in the townships of Amabel, North Bruce, Grey, and Kippel.

In 1878, the losses were still heavy in Southern and Central Michigan, but in 1879 the insect seemed to be moving northward, the greatest amount of injury being sustained in the northern part of the State, the fly being scarce in the middle of the State.

As regards its abundance in southeastern Michigan in 1878 and 1879, Mr. F. S. Sleeper, of Galesburg, near Kalamazoo, writes me as follows:

In February, 1878, I noticed what was to me something new. The month was very warm and spring-like. For nearly three weeks the temperature did not reach the freezing point. About the middle of the month I noticed many flies flying over the wheat and depositing their eggs, but, so far as I could see, none reached the "flax-seed" state. I have several times noticed the fly depositing her eggs as late in the autumn as October 26.

Since the summer of 1877 no very serious damage was done until last spring (1879). Then the fly put in an appearance. On the 26th of May, above one field of wheat the air was almost black with them. I never saw such a sight before. I had fears that the fall-sown wheat would be badly damaged, but it is not so, as none but early-sown wheat is damaged in the least. I presume it is owing to the fact that September was cold, so that probably the sudden atmospheric changes destroyed all that had not reached the pupa state.

In 1878 it did great damage in Dickson County, Tennessee. In Maryland, the winter wheat in the neighborhood of Baltimore, Md., was, in 1879 and the spring of 1880, seriously affected. In Central New York,

in Seneca and Tompkins counties, considerable damage was done in 1878 and 1879. About Watertown, N. Y., some injury was done in 1879, one field of wheat being ruined.

In 1879 apprehensions that injury would be caused by the fly were felt in Lowell, N. C.

These facts indicate that the losses from the Hessian Fly are greatest in the grain-raising areas of the middle and northwestern States, and adjoining regions of Canada, and that the New England States have been comparatively free from their attacks, though this is perhaps mainly due to the fact that so little wheat is cultivated there. No statistics as to the losses have ever been collected, either by the State or national governments, but they have been sufficient to occasion much consternation and alarm at certain years. By reference to the chapter on the supposed periodicity in its attacks or years of maximum abundance, the reader may learn approximately by the history of the past how often its more serious attacks may be probably renewed.

DESCRIPTION OF THE HESSIAN FLY.

This insect belongs to the Diptera or two-winged insects, of which the common house fly is the best-known type. It belongs to the family *Cecidomyiidae*, a large group of minute flies, resembling the crane flies or daddy-long-legs (*Tipulidae*), but of diminutive form. They are nearly all gall-flies, the females laying their eggs by means of the soft extensible end of the body which slides back and forth like the joints of a telescope. The irritation caused by the egg results in the swelling of the stems of plants, or the formation of tumors or galls on the leaves and buds. The Hessian Fly, as we shall see farther on, does not produce true galls in this way, but the presence of the insect in the flaxseed state, between the leaf and the stalk, causes the stem to swell, and the leaves to wither and die. The scientific name is *Cecidomyia destructor* of Say.

The female (Plate I, *f*; II, *A.*)—The body is rather slender, uniformly dark brown, the head is round, but somewhat flattened, the eyes are black, the wings uniformly dull smoky brown, while the legs are paler brown than the rest of the upper side of the body. The body, wings, and legs are provided with fine hair-like scales (Plate II, *A, c*), those on the wings being in many cases quite broad and ribbed, somewhat like the scales on the wings of a butterfly or moth. The pale brown antennae are about half as long as the body, the joints are very distinct, like a string of beads, each one being oval-cylindrical. There are seventeen joints, the two basal ones being large, nearly globular, flattened lengthwise, and nearly half as long as thick, and each of nearly equal size; joints 3–5 are longer than the remaining ones, and are slightly contracted in the middle; the remaining 6–17 gradually decrease in length, each joint being provided with about ten hairs, arranged in a rude whorl; the terminal joint (Plate II, *A, a'*) is long and conical. The legs are of the same color as the under side of the body, being a little paler than the back. The abdomen is rather full, with nine well-marked rings or segments, the

paler small ovipositor forming the tenth. The latter is one-half as thick as the ninth segment, and about two-thirds or quite as long; is slightly sinuous, and a little smaller at the end than at the base. The wings are dusky, with a fine fringe around the edge, and there are three veins. The subcostal vein ends near the outer third of the wing; the median vein arises from near the base of the submedian vein and runs nearly parallel to the subcostal vein, while a branch (its base disconnected with the main vein) extends along the middle of the wing; the submedian vein is well developed, at the base throwing off the median vein at a little distance from the base of the wing, and losing itself before turning down to the edge of the wing. The length of the fly is $2\frac{1}{2}$ millimeters, or about one line, *i. e.*, $\frac{1}{16}$ of an inch.

The male.—The male is rather smaller than the female, being distinguished by the long slender abdomen, and the longer and more hairy antennae. The joints of the latter (Fig. A, *a'*, *a'''*) are twenty in number, oval, the terminal one conical, and all provided with a few hairs, much longer than in the female, and arranged in a decidedly verticillate manner. "The abdomen in the living specimen is black or brownish black, with bands at the sutures both above and beneath, of a brick red, tawny yellow, or grayish color, varying in their width as this part of the body is more or less distended." (Fitch.) The claspers at the end of the body are stout, much more so than in *Cecidomyia leguminicola* of the clover.

The egg (Plate I, *a*, enlarged) is very minute, about a fiftieth of an inch long, cylindrical, pointed at each end, the shell shining and transparent, the egg being of a pale red color.

The larva.—After remaining about four days in the egg state, the larva or maggot of the Hessian Fly hatches, and is of the form represented by Plate I, Fig. *b*, and Plate II, Fig. B, Ba, Bb, Bc.

The body is soft, smooth, shining, oval cylindrical, beneath a little flattened, and consists of twelve segments besides the head, the latter soft, fleshy, and but slightly separated from the body, with very rudimentary mouth-parts (jaws, &c.). The rings or segments are moderately convex and tolerably distinct from one another; the sutures between the segments in the living larva being indicated by faint transverse lines of a greenish brown hue, according to Fitch, who also states that the mature worm, freshly taken from the roots of the wheat, measures about 0.15 of an inch in length by 0.06 inch in width. Mr. Riley informs us that there are nine pairs of minute spiracles, which appear as yellowish rounded tubercles.

The puparium or flaxseed state (Plate I, Fig. *c*, Plate II, Fig. D).—When fully grown the larva is ready to transform into the third or pupa stage of its transformations. The body turns brown, and finally of a bright chestnut color, while the skin loses all appearance of sutures, and assumes a rude spindle-shaped form, somewhat larger than the larva. This brown case protects the growing pupa within the skin of the latter, finally separating from the cast larva skin, called the pupa-case or

puparium, and which serves as a sort of cocoon to protect the pale, soft-bodied pupa within. While many two-winged gall-flies are protected by the galls within which they live, others, like the larval wheat and clover seed midge and the pitch-pine midge, spin true cocoons of silk; and the Hessian Fly is the only species of the genus or family, so far as we know, which assumes this puparium state, being peculiar to the house fly and other species of Muscidae and allied families, in which the pupa is said to be *coarctate*, i. e., protected by the cast dried brown skin of the maggot or larva.

From the decided resemblance to a flaxseed the insect, when at this stage of its transformations, is said to be in the "flaxseed" state. It is, however, rather flatter than a flaxseed, being pinched, as it were, at the head end of the body. I have taken the semi-pupa or incompletely-formed pupa from the flaxseed December 1. In this flaxseed state the partly-formed pupa resides during the five winter months of the year.

In early spring, during warm weather in April, the semi-pupa rapidly transforms into the complete pupal or chrysalis state.

The pupa (Plate II, C).—As we have not personally observed the mode in which the fly issues from the pupa and its case, we extract the following account from Fitch: By the time the insect reaches the pupa state the flaxseed case has become quite brittle, breaking asunder transversely if rudely handled, one of its ends slipping off from the insect within, like a thimble from the end of the finger.

The time for its last transformation having arrived, the pupa, by writhing and bending its body, breaks open its puparium or flaxseed case, crawls from it, and works its way upward within the sheath of the leaf until it comes to some cleft in the now dead, brittle, and elastic straw. Through this cleft it crowds its body until all except the tip of the abdomen is protruded into the air, the elasticity of the straw causing it to close together upon the tip of the abdomen sufficiently to hold the pupa in this situation secure from falling to the ground; and, as if to preserve the body in a horizontal position, the feet are slightly separated from the abdomen and directed obliquely downwards, with their tips pressed against the side of the straw, thus curiously serving, like the brace to a beam or to the arm of a signpost, to support the body from inclining downwards. Thus securely fixed and now freely exposed to the drying influence of the atmosphere, the outer membrane of the pupa exhales its moisture, and, as it becomes dried, cracks apart upon the back or upper side of the thorax. Out of this opening the inclosed fly protrudes its head and thorax, more and more, as it gradually withdraws its several members—the antennae, wings and legs—from the sheaths in which they are respectively enveloped—a process analogous to that of withdrawing the hand and its several fingers from a tight glove—until at length, entirely freed from its pupa-skin, the fly, now perfect in all its parts, usually walks a few steps further up the straw, where it pauses for its body and members to acquire more firmness and strength by the further evaporation of their moisture, after which it is ready to spread its wings and mount into the air.

The Hessian Fly is easily distinguishable in all its stages from the wheat midge, which belongs to a different genus, *Diplosis* (*D. tritici* of Kirby). The wheat midge is orange-colored, has a stouter body, with clear, transparent, and much broader wings, and pale-yellow legs, while the larvae are orange-colored, and live crowded around the wheat-grains

paler small ovipositor forming the tenth. The latter is of the ninth segment, and about two-thirds or quite as long as the ninth, and a little smaller at the end than at the base. It is dusky, with a fine fringe around the edge, and the tip is black. The subcostal vein ends near the outer third of the wing. The vein arises from near the base of the submedian vein, and runs parallel to the subcostal vein, while a branch (its union with the main vein) extends along the middle of the wing. The submedian vein is well developed, at the base throwing off the subcostal vein at a distance from the base of the wing, and losing it at the outer edge to the edge of the wing. The length of the submedian vein is one line, i. e., $\frac{1}{10}$ of an inch.

The male.—The male is rather smaller than the female, distinguished by the long slender abdomen, and by the long antennae. The joints of the latter (Fig. A) are all of an oval, the terminal one conical, and all are longer than in the female, and arranged in a similar manner. "The abdomen in the living species is yellow, or grayish color, varying in color, and is more or less distended." (Fitch.) The legs are stout, much more so than in the female.

The egg (Plate I, a, enlarged) is about $\frac{1}{10}$ of an inch long, cylindrical, pointed at one end. In the parent, the egg being of a pale yellow color.

The larva.—After remaining in the egg for a few days, or maggot of the Hessian Fly has appeared. (Plate I, Fig. b, and Plate II, Fig. c.)

The body is soft, smooth, shining, and is flattened, and consists of twelve segments. The head is soft, fleshy, and but slightly convex. The elementary mouth-parts (jaws, &c.) are small, convex and tolerably distinct. The segments in the living larva are marked with lines of a greenish brown hue. The mature worm, freshly taken, is about 0.15 of an inch in length. It has nine pairs of rounded tubercles.

The puparium or flaxseed.—When fully grown the larva is in the stage of its transformation. It is of a bright chestnut color, while the puparium assumes a rude spindle shape. This brown case finally separates from the larva.

and some of the volunteer wheat, jars, and—

and eggs laid by these flies on the same flies and their eggs to several of his deposited in July, the flaxseed state assumed brood of flies in October. This is certainly a three broods are possible under favorable conditions, may generally must, wait till September to maturity to breed their mischief much earlier, even a late brood of flies which will be in readiness so doubt, too, as in the case of all insects, varying to accelerate or retard the various transformations. (Lec-

White I, e, the fly of its natural size engaged (the leaf of wheat). The mode of oviposition has been described by Mr. Herrick:

the fly presses or furrows of the upper surface of the leaves (the leaf-shaped part) of the young wheat plant. While depositing the egg with her head towards the point or extremity of the leaf, the fly moves between the point and where the leaf joins and surrounds the point. The number of eggs laid on a single leaf varies from a single egg up to thirty,

Mr. Herrick says that—

the fly usually lays more than three eggs at one time without change of position. She frequently lays two, and generally but one. In case she lays but one egg, it takes less than a quarter of a minute, and less than a half a minute to lay three, all laid without a change of position on the part of the fly. After laying the first egg, she draws in her ovipositor soon to extend it again, at the same time laying the second, two, or three eggs that are next to be laid. She then flies from the leaf, alighting usually, not always, with head towards the end of the leaf. She appears to wipe the eggs off the jointed ovipositor. She really crowds the eggs off and touches the leaf, when by friction of the leaf and adhesion of the egg, the egg is held fast while the egg-tube is withdrawn. If the second and third are laid, she repeats the operation, after which she retracts her ovipositor, rests on the leaf a trice is depositing the fatal germs on another leaf. I say usually on the upper face, for occasionally eggs are laid on the stalk, and sometimes on the under face of the leaf. I have observed that the fly often makes many unsuccessful efforts to get an egg to adhere on the outer face of the leaf before she succeeds. I have seen her thus for two minutes before success crowned her efforts. The fly may thus be seen to experience that it is easier to deposit on the inner or upper face of the leaf and so generally choose that surface. We shall see, too, in the sequel that it is for the prospective maggot that the egg be placed on the upper surface. In warm days, more or less, as the weather is cool or warm, the eggs hatch. (Lec-

Mr. V. Riley describes as follows the process in the New York State Experiment Station:

I have very carefully studied the oviposition of the Hessian Fly, closely observing the act on several occasions; and as accurate observations on this point are easily made, I herewith transcribe my notes of several years ago:

The eggs are deposited in irregular rows in the longitudinal cavities and depressions of the leaf sheath between the stalk and sheath when this is loose, or on the leaves between

at the top of the plant; they spin a silk round genuine cocoon, smaller than a mustard seed, which remains in the ground just beneath the surface. So it will be seen that the forms and habits of the two insects are very dissimilar, and that they need not be confounded.

HABITS OF THE HESSIAN FLY.

Having become acquainted with the appearance of this two-winged gall-fly in its different stages, we are now prepared to study its habits; for an intimate knowledge of how it comports itself as an egg, larva, "flaxseed," and perfect winged fly is absolutely essential to the farmer who would endeavor intelligently to combat this pest.

Number of broods.—The Hessian Fly is double brooded; the "flax-seeds" or puparia being found on the winter wheat from late in the autumn, through the winter, until the early part or middle of April. The "flaxseeds" of this brood, from one to about twenty in number, are situated between the stalk and sheathing base of the leaf, at the roots of the young grain, slightly beneath the surface of the ground.

The "flaxseeds" of the second generation affect the wheat in the late spring and summer; but are situated higher up, an inch or two above the surface of the ground, at the lower joints of the straw.

In the ordinary course of nature, therefore [says Fitch], our crops of winter wheat are liable to two attacks of the Hessian Fly, one generation reared at its roots producing another, which occupies the lower joints of the stocks. Thus the larvæ and pupæ are present in it almost continually from the time the tender young blades appear above the ground in autumn till the grain ripens and is harvested the next summer. Our spring wheat, on the other hand, can rear but one brood of these insects; they consequently resort to it but little, if at all. Nor can the Hessian Fly sustain itself except in districts where winter wheat is cultivated in which for it to nestle during the autumn and winter.

As a general rule, then, there are two broods of the fly, the first laying their eggs late in April and in May, and the second brood of flies ovipositing* in August, during September, and perhaps a few early in October. Sometimes the flies appear earlier, as Professor Cook, who observed the insect in Michigan, says that "in July and August the flies again issue forth, and the cycle of changes for the year is complete. Thus we see that the flies are ready for work in the fall, much before the wheat is ready for them, and may attack a volunteer crop long before the usual crop is above ground or even sown."

A third brood may sometimes appear, as shown by Mr. B. Hulick, of Michigan. According to Professor Cook, Mr. Hulick found the empty "flax-seeds" on volunteer wheat in September. On Professor Cook's expressing some doubt whether the fly had issued, suggesting that it might be the parasite that had eaten the fly and come forth, as the time appeared to

* Mr. F. S. Sleeper writes us that he has on one occasion seen the Hessian flies laying their eggs as late as October 26. In February, 1878, during very mild weather, he observed them laying their eggs in February. See his statements farther on.

him too short, Mr. Hulick at once planted some of the volunteer wheat, still containing the "flaxseed," in close jars, and—

Saw many of the flies issue; and, more, had eggs laid by these flies on the same wheat in October. Mr. Hulick showed these flies and their eggs to several of his neighbors. In this case the eggs were deposited in July, the flaxseed state assumed in September, from which came a third brood of flies in October. This is certainly a very important matter, as it shows that three broods are possible under favorable conditions. That while the fall flies may, nay generally must, wait till September to deposit eggs, they only want opportunity to breed their mischief much earlier, even in July or August, and thus propagate a late brood of flies which will be in readiness for even the latest sown wheat. No doubt, too, as in the case of all insects, varying degrees of heat or cold will accelerate or retard the various transformations. (Lecture, &c., p. 9.)

Mode of egg laying (see Plate I, *e*, the fly of its natural size engaged in laying its eggs on the leaf of wheat). The mode of oviposition has thus been described by Mr. Herrick:

The eggs are laid in the long creases or furrows of the upper surface of the leaves (*i. e.*, the blade or strap-shaped part) of the young wheat plant. While depositing her eggs the insect stands with her head towards the point or extremity of the leaf, and at various distances between the point and where the leaf joins and surrounds the stalk. The number found on a single leaf varies from a single egg up to thirty, or even more.

Professor Cook says that—

The fly very rarely lays more than three eggs at one time without change of position. She more frequently lays two, and generally but one. In case she lays but one it takes less than a quarter of a minute, and less than a half a minute to lay three, when they are all laid without a change of position on the part of the fly. After laying she seems to draw in her ovipositor soon to extend it again, at the same time crowding into it the one, two, or three eggs that are next to be laid. She then flies to another leaf, alighting usually, not always, with head towards the end of the leaf. She then appears to wipe the eggs off the jointed ovipositor. She really crowds the egg till the end touches the leaf, when by friction of the leaf and adhesion of the egg the latter is held fast while the egg-tube is withdrawn. If the second and third are to be laid she repeats the operation, after which she retracts her ovipositor, restocks it, and in a trice is depositing the fatal germs on another leaf. I say usually on the upper surface, for occasionally eggs are laid on the stalk, and sometimes on the under side of a leaf. I have observed that the fly often makes many unsuccessful efforts to cause the egg to adhere on the outer face of the leaf before she succeeds. I have seen a fly work thus for two minutes before success crowned her efforts. The fly may thus learn by experience that it is easier to deposit on the inner or upper face of the blade, and so generally choose that surface. We shall see, too, in the sequel that it is better for the prospective maggot that the egg be placed on the upper surface. In four to ten days, more or less, as the weather is cool or warm, the eggs hatch. (Lecture, p. 7.)

Mr. C. V. Riley describes as follows the process in the *New York Tribune*:

I have very carefully studied the oviposition of the Hessian Fly, closely observing the female in the act on several occasions; and as accurate observations on this point are not easily made, I herewith transcribe my notes of several years ago:

Eggs deposited in irregular rows in the longitudinal cavities and depressions of wheat stalks between the stalk and sheath when this is loose, or on the leaves between

the natural ridge or carinae of the upper surface, this last being the more common habit. Ordinarily there are from five to ten in a row, but sometimes more. Each egg .02 inch long, cylindrical, rounded at each end, soft, translucent, and pale orange red in color. Before hatching, the pale sides of the inclosed larva show through the shell. Larva hatched in four days; crawls down leaf to base of sheath, which on young grain is at crown of root. The orange-red color is soon lost, and the larva becomes pale, translucent, and plump, sinking more or less into the stalk by the depleting process kept up.

In an article in a Saint Louis paper I described, last June, the process of oviposition on the leaves, and my own observations in Missouri accord entirely with those of E. Tilghman recorded in 1820, and of E. C. Herrick in 1844, and quoted by Fitch in his essay on the Hessian Fly (Albany, 1846), with the exception that they do not mention the exceptional habit of pushing the eggs between the sheath and the stalk, owing doubtless to the fact that their observations were made solely on the autumn brood of flies ovipositing on the young plants, the habit being more common in the early summer brood when the plants are larger.

Mr. William Strong, of Kalamazoo County, Michigan, thus describes the process, adding some particulars of interest:

I have seen the wheat plant with many of the maggots at work before there was any stalk for the fly to lay its eggs on, by introducing its extensile abdominal tip under the leaf sheath. Even this fall I have seen this very thing when there was as yet but one shoot from the kernel having but three leaves, the wheat having been sowed not more than three weeks. I have seen these maggots when too small to be seen without the aid of a glass, so low down toward the kernel, which was sowed with a drill, that if the fly had deposited the eggs under the leaf on the stalk, if there had been one there, she would have been obliged to use a spade to dig to get a chance. I am not the only one who believes that the egg is laid on the leaf and hatches there, when the small maggot works its way down inside of the leaf as low as possible. If there should be fifteen or twenty on one leaf (not a large number to find the past year under one leaf), of course as they took their places they would be somewhat in rows, but they, of course, are not the "eggs placed in the longitudinal grooves of the stalk."

In Solon Robinson's "Facts for Farmers," page 214, we read: "The female deposits her eggs soon after the wheat begins to grow, * * * in the cavities between the little ridges of the blades. In from four to fifteen days the eggs hatch and the diminutive maggots work down into the leaf sheath and there spend the winter." In the Kalamazoo Telegraph for November 7, this year, are a few lines upon the Hessian Fly by M. B. Batcham, of Ohio. He is too well known to need an introduction at this time. He says: "In the spring, with the first warm weather, the fly will come forth and deposit its eggs upon the leaf, which will then soon hatch, when the worms, crawling down the leaf, feed upon the stalk, injuring its growth, often causing it to die." A reason given by some why the fly does not injure red wheat as much as white is because the leaf of the red grows so long and slants down from the shoot so that when the egg hatches the maggot works down the wrong way, falls to the ground, and so many fail to harm the wheat.

A writer in the Country Gentleman, Mr. Caleb S. Fuller, of Jackson County, Michigan, says:

The fly commences as soon as the wheat is up an inch high. I placed in a glass fruit jar some stools of wheat which was sown on the 31st of August, and about the 15th of October the fly hatched out of the brown eggs [puparia] which were in the wheat in large numbers, and was a lively little black fellow about one-eighth of an inch long. Now, if the eggs were deposited about the 8th of September, as that is as soon as the wheat would be large enough for them, it would give them about 37 days to mature so as to fly again, though they might hatch a little sooner or later in the open field. I cannot say as to that; have no certain means of knowing.

The flies of the second brood are, in Southern Michigan, ready to deposit their eggs late in April or early in May "on spring wheat or barley which is sufficiently advanced, in lieu of which they deposit on the wheat again, not on the basal or radical leaves, but on the leaves which will be above the first or second, rarely the third, joints." (Cook.)

Habits of the larva.—As soon as the footless larva or maggot hatches, it makes its way down the leaf to the base of the sheath, which, in the young winter wheat, is at the crown of the root.

Here [says Herriek] it fastens, lengthwise, and head downwards, to the tender stalk, and lives upon the sap. It does not gnaw the stalk, nor does it enter the central cavity thereof; but, as the larva increases in size, it gradually becomes imbedded in the substance of the stalk. After taking its station, the larva moves no more, gradually loses its reddish color and wrinkled appearance, becomes plump and torpid, is at first semi-translucent, and then more and more clouded with intestinal white spots; and when near maturity, the middle of the intestinal parts is of a greenish color. In five or six weeks (varying with the season) the larva begins to turn brown, and soon becomes of a bright chestnut color, bearing some resemblance to a flaxseed.

EFFECT OF THE WORM OR LARVA ON THE WHEAT.

As has been stated, the worm in autumn lies at the sheathing base of the leaves just above the roots, at or near the surface of the soil. It is easy to detect the flaxseed from its large size and chestnut-brown color, by separating the leaf from the stalk of the young wheat in October and November, when the worm has stopped feeding and is incased in its brown sack. Scattered shoots will be found, withered and changed to a light yellow color, and, as Fitch observes, strongly contrasting with the rich green of the vigorous uninjured plants. (See Plate I, representing a healthy stalk on the right and a dwarfed plant on the left, containing three flaxseeds, with the leaves partly withered.) The worms, before assuming the flaxseed state, rest between the leaves and the stalk; their soft fleshy undeveloped mouth-parts do not enable them to gnaw the surface of the plant, but the sap is supposed to be absorbed directly through the walls of the body, and thus they are said to feed by imbibition; this weakens the plant and causes it to become unhealthy and turn yellow and die; moreover, although this point is disputed by Dr. Fitch, the presence of the worms causes the formation of a gall-like swelling or enlargement of the stalk, an abnormal growth of the plant being caused by the slight interruption to the flow of the sap. Of course when six or a dozen of these comparatively large flaxseeds are lodged under the base of the leaves the plant turns yellow and dies, as if the roots had been affected.

How a field of winter wheat may be attacked and affected by the Hessian Fly may be seen by reading the following account in the *Cultivator and Country Gentleman*:

Last fall the appearance of the wheat plant on different fields and locations was very different. On strong and level lands, little injury was shown. Hilly fields, or where there was a ridge or worn point, or where the rock cropped nearer the surface,

the wheat appeared injured or dead, as also when sown after spring grain, particularly oats. That the fly either enters the ground or remains in the dry stubble till the size of the wheat affords a lodgment, appears true. As an instance, I note the following facts: An acre of potato ground of 1876 was sown to oats in 1877. It was in fair condition, and a heavy crop was secured. Surrounding this piece of oats on three sides was a meadow, the highway bordering the other side. A good crop of hay was taken in June, and the field was all plowed in July. The after cultivation was the same, putting the field in an excellent condition for the crop. Seeding was through early in September, and in a few days the whole field was nearly covered with the growing wheat, and was very much admired, both for its beautiful green and its superior culture. All at once the wheat on the oat stubble was turning very yellow, in strong contrast to the deep green on the surrounding meadow. In the hollows, on the accumulated wash of ages, the wheat was very large and kept green and growing; while on the sharp points of knolls and hard clay ridges, it was nearly gone. On a piece of new land near by, where never a kernel of grain was grown before, no fly or injury could be seen.

The appearance of the fly was general, as soon as one or two leaves gave them a lodgment. Owing to the superior warmth and moisture of the entire fall months, wheat sowed on strong land tillered largely. The insects took the first tiller and stuck to it, while two and even four others came out and covered the ground. On poorer parts of the field the plant could not tiller so much, and here the injury showed most. Up to this date the crop has wintered well, a deep layer of snow now keeps insects and wheat alike. About the 1st of May this entire brood will be ready to deposit their eggs, and they will number millions.

That a field of wheat may recuperate after a favorable winter, and how such a field looks early in the following June, is well brought out by the following extract from the *Prairie Farmer*:

The early sown wheat that was badly eaten by the Hessian Fly last fall, but which has been apparently entirely recuperated by the remarkably favorable winter and spring just passed, is more seriously damaged by the insect than many farmers are probably aware of. I visited to-day a thirty-acre field, sowed on the 5th, 6th, and 7th days of September. Early in October it looked very badly—was yellow and showed bare ground in many places, and the plants for a long time seemed to be dwindling and growing smaller. The fine spring, however, brought it out apparently all right. It now stands five feet four to six inches high, very well headed, and seemingly good for from thirty to thirty-five bushels to the acre. I examined the field carefully in ten places, taking twenty wheat stalks as they stood in the drill row at each place, with this result: Number of stalks examined, 200; number of stalks containing the fly, 134, or two-thirds of the whole. Many of the stalks, however, had only one larva, and these will probably not be much affected. The insects are all of full size, of a chestnut color, and plainly visible in the lowest joint and the one next above—about twice as many were found in the lower joint as in the upper one. This, I suppose, indicates a loss to the crop of from 30 to 50 per cent.

We had heavy rains on the 8th, 9th, and 10th of September, I think, which suspended the operation of seeding till the 12th or after. This seems to be the dividing line, separating the fields badly damaged from those that escaped with little injury. In a part of the same field (potato ground) sowed, near the last of September, with the same kind of wheat, the number of plants examined was 100; affected with fly, 12. In other fields the rate was four to six to the hundred.

Many fields of Mediterranean are lodging. The Clawson stands well, and by reason of its stiff straw and vigorous growth promises to withstand the ravages of the fly better than the more feebly-growing and weaker-strawed sorts.

ARVINE C. WALES.

STARK COUNTY, OHIO, June 7.

Another extract from the *Cultivator and Country Gentleman* bears directly on this important point.

There is a dispute among good farmers whether wheat injured by the Hessian Fly is irreparably damaged. Mr. F. C. Root thinks it is, as he says when the central stalk is eaten out the plant is either dead, or able to make only a feeble growth. If it makes a head, it will perfect only one or two seeds to a plant. Mr. Jesse Dewey qualifies this statement thus: *If the land is rich enough*, though the central stalk be injured, the wheat plant will stool, and from its side roots send up stalks and perfect a fair crop. I have no doubt that both of these excellent farmers are right. On the great majority of fields, the injury to the wheat plant in the fall means the destruction of the crop. When the central plant has been injured, the side shoots have not enough vitality to perfect much seed. Yet there may be land rich enough to make a crop from the second growth, provided the Hessian Fly next spring is not numerous enough to do serious damage. Very much now depends on the character of the coming winter. A season which, under ordinary circumstances, would be favorable, may also save myriads of Hessian Flies. There was much more "crinkled" wheat last summer than usual, and I have little doubt that the cause is to be found in the heavy mantle of snow, which preserved a greater number than usual of the Hessian Flies through the winter. The wheat crop this fall would have suffered more than usual in any event, but the evil has been greatly aggravated by the warm and generally dry weather after wheat-sowing. We had no killing frost until near November, nor frost of any kind until the middle of October. With frosts in their usual season, and not sowing too late, there need be little danger from the Hessian Fly. But it is the poorness of the soil which leads farmers, year by year, to sow their wheat earlier in order to get a larger growth. Making the soil richer removes the difficulty by removing its original and principal cause.—W. J. F., Monroe County, N. Y.

INFLUENCE OF THE WEATHER AND FAVORABLE AND UNFAVORABLE SEASONS.

To properly discuss this very important subject would require an intimate knowledge of the meteorological conditions and the relative abundance or rarity of the Hessian Fly during each year since its first appearance in this country in 1776. All that we can say with our present exceedingly imperfect knowledge bears but slightly on this point and must be considered as simply provisional. We may here quote from the *Cultivator and Country Gentleman* what has been stated by Mr. Riley in speaking of the condition of the Hessian Fly in 1877:

The Hessian Fly is rather an insect of moist climates and mild latitudes; and therefore, unlike the chinch bug, its multiplication has been favored by the cool and wet summers and autumns of the last three years. While the rainy period which as a general statement may be said to have commenced in May, 1875, and continued to the present date, and during which time there have neither been severe droughts, nor continued summer heats, the chinch-bug has so nearly disappeared that its depredations have been scarcely noticed, the Hessian Fly has developed and thrived, and to the extent that if the weather favors—that is, if from now to harvest it should continue cool and moist or warm and wet—the damage likely to be done to the incoming and the following crop can scarcely be estimated. But if dry weather prevails from this time to harvest, the damage done can hardly be considerable—and if it should turn very dry and hot, all danger from serious depredations from him may be cast out of the account, in measuring the outcome of the crop—since a certain amount of moisture is absolutely necessary for the successful development of the several stages in the growth and progress of this insect scourge. But then Professor Riley warned

me against drawing final conclusions on insufficient data, it being quite possible that other forces and causes appearing might bring about a quite different and unexpected result. Nevertheless, there are many reasons for expecting a dry spring, a warm harvest, and a hot summer, and comparatively trifling damage to be done by the fly on the wheat harvest of 1878.—W. J. F.

That this fly flourishes best in a rather warm and moist season, is shown by its habits. The flies hover in the spring and autumn over the wheat-fields in countless numbers, especially at morning and evening, avoiding the direct heat of the sun.

PARASITES OF THE HESSIAN FLY.

How useful, nay indispensable, parasitic insects may prove in keeping the noxious ones within due limits is well illustrated by the case of this fly, for whenever it suddenly disappears from a given locality, this is usually due to the attacks of its parasites, and especially one Chalcid fly, the *Semiotellus destructor*, first described by Say.

This is a hymenopterous insect, having four wings and belonging to the same order of insects as the saw-flies, four-winged gall-flies (*Cynips*), the larger ichneumons, and the wasps and bees. It is a member of the family *Chalcidæ*. As stated in our *Guide to the Study of Insects*, this is a group of great extent, the species being of small size; they are often of shiny colors, as the name of the principal genus implies, being either bronze or metallic. They also have elbowed antennæ with from six to fourteen joints, and the wings are often deficient in veins. The abdomen is usually smaller, and composed of seven rings in the male, and of six in the female, the latter often having a short but visible ovipositor, a horny tube consisting of three pairs of stout bristles closely united and forming a quite solid tube. Some species are wingless. There are 1,200 species of the family known in Europe, and there are, in all probability, at least 1,000 in the United States. Few of them are over a line in length.

Semiotellus destructor, male. (Plate I. Fig. *i* much enlarged.) The head is transversely oblong, or rather cubical, being rather wider than long, and slightly broader than the thorax when seen from above, being full, somewhat rounded in front, and hollowed out behind next to the thorax. The eyes are dull red, reaching, when seen above, behind the middle of the head. The antennæ are elbowed, and when bent back reach to about the middle of the thorax; they are yellow on the basal half, black beyond. For a further account of the antennæ we quote as follows from Fitch, our specimens being defective in this respect:

In the male they are of uniform thickness through their entire length. Viewed with a common magnifier they appear ten-jointed, though the last joints are usually so compacted that in the dried specimen the full number cannot be distinctly discerned. When highly magnified two small additional transverse joints may usually be discerned, more or less distinctly, between the second and the third joints, of which the first is rather smaller than the second. The joints are slightly longer than thick, and rather narrower towards their bases. The second joint is longer than the others, its length being about double its thickness. The last joint is more than twice as long as

thick, its apex appearing to be cut off transversely, with a minute teat-like process protruded therefrom.

The thorax is about twice as long as broad, and widest at the insertion of the fore-wings; like the head, the crust is coarsely punctured. The fore-wings are broad, triangular, well rounded externally; the subcostal vein is very thick, being strongly marked, and after joining the costal or front edge of the wing for a short distance, just beyond the middle of the wing, is bent in towards the middle of the wing, ending in a knob-like expansion with a slight point extending towards the costal edge of the wing. Fitch represents a slightly marked vein extending to the outer edge of the wing, but this is absent in some specimens. There is an incomplete median and submedian vein, only perceptible under strong magnifying powers, the base of the median being quite disconnected from the submedian. In one of my specimens there was no vein extending from the subcostal knob to the end of the wing.

The legs are pale straw-yellow, the fore shank-joints (tibiae) and toe-joints (tarsi) brownish; the third hip-joints (femora) are dusky on the basal half, while the hind terminal tarsal joints are brown. The abdomen is small, black, while the head and thorax are bright metallic green, sometimes blue. The abdomen is also smooth and polished, much flattened, oval, not so wide as the thorax, broad at the end and suddenly pointed (mucronate) at the tip. It has a large yellowish patch on the upper and under side of the second segment. Length of the body 2-2½ millimeters (.08-.11 inch).

The female differs in her greater size and rather slenderer body, and the more club-shaped antennae, the terminal joint being twice as long as thick. The abdomen is as long and as wide as the thorax, ending in a long sharp point, the short but distinct ovipositor extending slightly beyond the tip of the body. There is a slightly marked pale spot above on the second segment. Length 2½-3 millimeters (.10-.12 inch).

This parasite was first described by Say, his specimens occurring at or near Philadelphia; it was observed by Herrick in 1833, in Connecticut, and in 1877 we bred it from puparia of the Hessian Fly received from Ohio; and, as stated by Professor Cook, it is sufficiently abundant in Michigan to destroy the Hessian Fly in great numbers, and is probably distributed throughout the Hessian Fly area.

So destructive is this and other parasites to the Hessian Fly that as early as 1841 Herrick claimed that in Connecticut "a very large proportion, probably *more than nine-tenths*, of every generation of the Hessian Fly is destroyed by parasites." This work is mainly, we doubt not, done by the chalcid parasite under consideration. It is to this insect more than to any other means in nature that we owe the general immunity in certain years from the attacks of the Hessian Fly in most wheat regions, and to this cause that during certain years the fly is kept wholly within bounds. Few people, even naturalists, have any adequate idea of the good done by these minute parasites. What was the fact in Connecticut,

in 1841, and the few years preceding, has been the case in Michigan, according to Mr. F. S. Sleeper, of Galesburg, Mich., who writes us that the Hessian Fly was nearly exterminated in Kalamazoo County by *Semiotellus destructor*, nearly all the "flaxseeds" in the crop of 1877 having been destroyed by this friendly parasite. He writes us that in the autumn of 1877 he found these parasites in the wheat-fields in countless numbers, and that the perfect Hessian Fly was difficult to find.

No one since Herrick recorded his observations has made very careful observations on the habits of these parasites. He states that:

It pierces the sheath of the stalk (making a hole too small to be detected by a powerful microscope), and deposits an egg in the pupa within. This is done chiefly in June. The perfect insect is evolved in the summer and autumn succeeding, eating its way through the puparium and the sheath of the leaf.

Herrick also states that a second parasite, very similar to the *Semiotellus destructor*, "but with mere rudiments of wings, is sometimes evolved from the pupæ of the Hessian Fly. I am in doubt whether it should be considered a distinct species or only a variety."

A third parasite was reared by Herrick in Connecticut. It is an insect of the tribe *Chalcidæ*, whose genus he did not determine. Its habits were like those of *Semiotellus*, and wingless females of this species were also found.

A fourth parasite, noticed by Herrick, belongs to Latreille's tribe *Oxyuri*, but the genus was not determined. In habits it agreed with the foregoing parasites, but it was evolved later in the year. Herrick adds that all the parasites mentioned "are likewise evolved in the spring from the Hessian Fly pupæ of the summer previous."

The fifth parasite has quite different habits. It lays its eggs in those of the Hessian Fly. Herrick, its first discoverer, thus speaks of it:

The insect is abundant in the autumn. I first saw it September 23, 1833, in the act of depositing its eggs in the eggs of the Hessian Fly. From subsequent observations it appears that four or five eggs are laid in a single egg of the Hessian Fly. The latter egg hatches, and the animal advances to the pupa state as usual, but from the puparium no Hessian Fly ever comes forth. This parasite forms within the puparium a silky cocoon of a brownish color.

It is probable that it is the species first discovered by Herrick in Connecticut which Professor Cook has detected ovipositing in the eggs of the Hessian Fly.

It is black and looks not unlike a tiny gnat. The female feels for the egg with her antennæ, and when found intrudes the fatal egg, which, I find, takes three-fourths of a minute; full three times as long as it takes the Hessian Fly. The little parasite is much longer, too, in finding the eggs than is the fly in laying them. I find that each egg receives one, two, or three of the parasite's eggs. The eggs of these latter are tardy in hatching, so that the larva of the parasite may feed on the maggot of the Hessian Fly, not her eggs. These pupate in the puparium of the fly."

Platygaster error Fitch?—Having received one of these egg-parasites from Professor Cook, I find it to be so much like the *Platygaster error* of Fitch (Fig. 1) that I refer it to that species, though with a doubt. This is probably also the parasite referred to by Mr. Herrick.

It is shining black ; the head is finely punctured, rounded, and slightly broader than long, being about as wide as the thorax. The antennæ are about as long as the head and thorax ; they are slender, but apparently a little stouter than in *P. error*, the penultimate joints being a little broader and squarer than he represents (and they are very different from *Platygaster tipulæ*), these joints not being "twice as long as thick," but only $\frac{1}{4}$ to $\frac{1}{3}$ longer, much as represented by Fitch in his figure;* the terminal joint is long, oval, not so wide as those just behind it, and it tapers to a rounded point. The thorax is rounded ovate, but little longer than broad, black, with the scutellum high, rounded and pitted. The abdomen is flattened, oval, twice as long as wide, being a little longer than the thorax, but not quite so wide. The legs are pitchy black on the femora ; the tibiæ dull reddish brown, darker towards the end ; the tarsi are 5-jointed, dark brown, hairy, with the basal joint reddish at the base. (Fitch says the legs of *P. error* are pitchy black ; but in the specimen before me they have a decided reddish tinge.) The wings are veinless, clear transparent, irised. Length $1\frac{1}{8}$ millimeters, being a little larger than Fitch's *P. error*, which was .05 inch long. I am disposed to refer this specimen to Fitch's species, but should it be found to be quite distinct, it may receive the name *Platygaster herrickii*. It seems to be a genuine *Platygaster*.

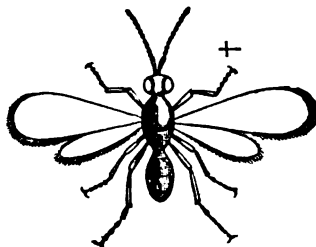


FIG. 1.—Egg-parasite of the Hessian Fly.

Fitch states that *Platygaster error* is seen in company with the wheat midge (*Diplosis tritici*) on the wheat ears in New York, and is very numerous some years, but he thinks it doubtful whether it preys upon the midge.

REMEDIES, PREVENTIVE AND GENERAL.

Having become familiar with the habits of this insect, which can be readily observed by farmers, it is not difficult to apply such remedies as the experience of wheat raisers of the past century in different parts of the wheat region of the United States has nearly universally found serviceable. Remembering that the first brood of flies appear in August and continue to hover over the fields until late in September, as if waiting for the fall-sown wheat to appear, it is evident that by delaying the date of sowing until after a frost cold enough to kill the flies, they may be circumvented ; for if the wheat is sown later than the 20th of September in nearly all the Middle and Northern States, the early frosts will destroy these delicate insects. Late sowing, then, is the most general, important, and easily applied preventive remedy.

Late sowing of most of the wheat-seed.—All writers, both entomological and agricultural, concur in recommending this easily-applied remedy ;

* Sixth report on the noxious and other insects of the State of New York, by Asa Fitch, M. D. Pl. 1, fig. 4, a, b. The figure is from Packard's Guide to the Study of Insects.

that at least a part of the wheat should not be sown until after the 20th of September in the Northern States. The writings of Fitch, Harris, and of Cook concur in recommending this course in a district ridden by these pests, even though the wheat is in danger of being injured by the cold autumnal or the winter weather. As the year 1877 was a bad fly year, we quote the following explicit testimony from Professor Cook's pamphlet:

In all the century's experience in our country with this insect, this has been the most certain and satisfactory method to prevent its ravages. Even more than thirty years ago this measure is spoken of as unanimously sanctioned and the most efficient of remedies. During the past season [1877] I have reliable reports from the following counties: Ottawa, Van Buren, Cass, Kalamazoo, Hillsdale, Saint Joseph, and Lapeer, and with few exceptions it is stated that early-sown wheat was injured badly, while all sown after September 20 nearly escaped. In traveling through Ohio and Southern Michigan, I found I could often tell the early from the late-sown wheat for long distances, the former looking like oat-plants after a hard frost, the latter appearing green and healthy. Often in the same field the line of demarkation was very distinct

The following newspaper extracts bear upon this subject:

Perhaps the most effectual remedy, or rather preventive, is late sowing. No wheat should be sown in localities where they have already appeared, or in districts adjoining, until September 15, and if it is deferred until the 20th it would be all the better. Repeated rolling is said to destroy some of the larvæ, and burning the stubble, where practicable, would certainly destroy many and thus prevent so great devastation of the succeeding crop. The great objection to either rolling or burning is that it destroys both friend and foe alike.

Great care should always be used in destroying all noxious insects lest we also destroy the beneficial ones; the chief of which are the Ichneumon and Chalcid flies. In the counties of Yates, Seneca, Tompkins, and Cayuga, where the Hessian Flies have already made their appearance, it would appear wiser to fit the ground perfectly, apply extra fertilizers, and sow late, rather than run any risk or trust to any methods of destruction. If all infested and contiguous districts would sow late enough so that the wheat would not appear above ground before September 25, I believe the fly could be effectually starved out.—[I. P. Roberts, professor of agriculture, Cornell University, in the *Rural New Yorker*, September 8, 1877.

By the attacks of this (the second or spring) brood of worms, the lower joints of the wheat are weakened, and as soon as the head is formed, and the growth is heavy, the weakened joints give way and the wheat falls over, or, as it is commonly expressed, it "crinkles." If but few larvæ are at work, there will be some kernels of grain in the heads thus affected, but they will be more or less shrunken. If the insects are plenty, the head seldom "fills," and the field looks as if cattle or something else had passed through it, tangling up and throwing down the straw in every direction.

There are thus two generations of the Hessian Fly each year, one of which subsists and may be always found at the crown of the roots, and the other at some joint above, and never at the root. If the wheat could be fed off by sheep in the fall, between the time that the eggs are laid and the time of their hatching, this remedy would be perfect. Unfortunately, the wheat is then young, and farmers do not like to risk thus feeding it off. The only remedy left, therefore, is to sow so late that the wheat will not appear above ground before October 1. In this case there is the added risk of winter-killing, because the plants have not time enough to get well rooted before winter. On well-drained, rich land, this danger is greatly prevented, and therefore late sowing and thorough farming seem to be the only available means yet discovered to avoid great losses from the ravages of the Hessian Fly. Fortunately the parasitic enemies of the fly increase rapidly, and after a year or two of great losses from this insect its numbers are reduced so much as scarcely to be noticed for some years.—[*Chicago Tribune*]

I find in several counties of Northern Ohio, where I have traveled of late, a good deal of injury is done to the young wheat by the fly—more than has occurred before for quite a number of years. This is no doubt owing to the general practice of sowing wheat early, and the fact that it made a remarkably fine growth during September, when the warm weather was also very favorable for the propagation of the flies. The worms have now gone into the pupa or “flaxseed” state, and if the winter is not too wet or cold for them, it is likely the new brood next spring will prove quite mischievous.—[B., *Cultivator and Country Gentleman*.]

Pennsylvania German farmers have a claim to be considered good zoologists by their knowledge of animals, from the noble horse down to the insect tribe, that so beset them with labor and loss. The German farmers have been apt and successful in contesting the insect enemies of all crops. The wheat midge, which came in upon us twenty years ago in vast numbers the last of June and the first of July, made his home in the wheat-heads, and nurtured his progeny in the cell prepared for the expectant berry, and appropriated the element nature designed for the perfection of the seed to his own use. This insect for a time literally destroyed the wheat product. Whether it was a scientific discovery that taught the farmers of Lancaster County how to get rid of this destructive insect or not, I have never learned. But I do know that I purchased and carried to my farm Lancaster red wheat which I was instructed to sow in August, and in doing so freed my farm of this pest. Continued early sowing proved successful up to the present season, when this practice brought the Hessian Fly, who begins at the root of the wheat plant. If the mother fly can get an opportunity to deposit its eggs in the fall season, the larva will stand the winter imbedded in a stalk of wheat (which is a well-tillered plant), and brings forth enough Hessian Fly to destroy the wheat before harvest time. The habit of this Hessian Fly is to bury in the ground with the first frost of the fall season. A Lancaster farmer said to me not long since, we must sow our wheat late this fall if we would avoid the fly. Early-sown wheat was a failure in Pennsylvania to an extent, in my estimation, that reduces this cereal 30 per cent. below our general average. The corn crop over the entire State is not an average one. The oat crop is above the average. The buckwheat crop, generally relied upon in the northern and western portions of our State as one of the paying bread grains, has been very extensively injured by the grasshopper, and cannot be expected to yield more than one-half the usual amount.—[V. E. Piolet's address before the Berks County Agricultural Society, at Reading.]

The letter below from W. B. Billings to the Elmira (N. Y.) Farmer's Club, elicited the appended discussion, as reported in the *Husbandman* :

I have perused your club reports with much interest, especially those relating to the Hessian Fly. In an experience of fifteen years of wheat raising I have had about four acres of wheat destroyed by this pest. Eight years ago I sowed a field of ten acres to wheat, four acres of which were gravel, the remaining six acres being of sandy loam, in places so wet that I had to under-drain it. Wheat put in in good condition; land new—had been in cultivation only the two previous years. Now for the results: During the fall the wheat on the gravelly part started quicker, and when winter set in looked better, the fly doing no appreciable damage to any part of the field; but in the spring when the wheat had apparently reached about six inches in height, that on the gravel commenced turning yellow about the roots, and from that time forward grew thinner and most beautifully less until harvest, when I cut it with a mower and raked it with a wheel-rake, getting about as much straw as farmers generally get from raking a like amount of ordinary wheat stubble. On the remaining part of the field the wheat was good, no noticeable damage being done by the fly. A few years previous to this I knew of a field of spring wheat that was almost entirely destroyed by the Hessian Fly, less wheat being harvested than was sown. It is generally conceded that there are two crops, or hatchings, of the fly during the growth of the wheat; the first in the fall and working until frost comes; the second in the spring, and continuing its depredations until harvest. Late sowing is generally recommended as a preventive. Why should it be so? How do you account for the fly working in wheat

growing on warm gravelly land, while that on the moist soil escaped harm? If, as above assumed, there are two crops of insects hatched per year, how does late sowing prevent their depredations? And how can you account for the loss of the spring wheat crop mentioned? Where was the first or small crop hatched, and where did the flies remain until spring? Fresh lime is recommended as preventing the ravages of this pest; can you tell me at what particular time, spring or fall, the lime should be sown to cause the greatest destruction of the fly? Any information from the club on the subject will be thankfully received.

J. S. VAN DUZER. It must not be assumed that the flies which damaged the spring wheat were hatched in that field. The parent flies may have come from a distant field.

President HOFFMAN. To my mind the case is easily explained, so far as the spring wheat is concerned. The fly is migratory. We are told by those who have studied its habits that it flies over districts as much as twenty miles in breadth in the course of the year.

The writer furnishes the explanation of the greater damage done by the fly on his gravelly land. There the wheat came earlier, and was therefore in condition to receive the deposit of eggs, while the more backward wheat was not. It accords with the theory that late sowing is a measure of prevention against the ravages of the fly. I had last fall an illustration of the protection afforded by late sowing. On a small piece I wanted to sow wheat after wheat. Before plowing the stubble the volunteer crop had made a growth of perhaps six inches. In examining one of the plants I found twenty-five of the larvæ. In many others there were a dozen or more. I destroyed this growth by thorough cultivation, and, after proper fitting, sowed the seed. In the plants that came from that late sowing there were very few larvæ. They came too late to receive the eggs. It is well known that the fly deposits the eggs on the leaves of the wheat, and that its work ceases after some frosts come. The late sowing brings the growth too late for the fly. The fly which does the mischief in the spring is not hatched in the fall—or at least is not fully developed. It comes out in the spring, lays a new crop of eggs on the leaves of the growing plants, and the insects which hatch from these eggs are those which do the real injury to the wheat. If the time can be ascertained when the eggs are deposited on the leaves, then is the time to sow lime. I do not know that it will prevent the eggs from hatching. My observation of the work done by the fly has taught me one lesson. It is that no wheat should be sown except on rich land, where the plants will be strong and therefore able to resist the ravages of the insects.—[*Western Farmer's Journal*, March 29, 1878.]

It should, however, be borne in mind that late sowing exposes the wheat to the attacks of the wheat-midge (*Diplosis tritici*) and also to the rust, while also by late sowing the plants are less advanced and less fitted to withstand the rigors of the winter.

Early sowing as a remedy.—Still there are some who adhere to early sowing, as on the whole the best thing to do. We insert the following testimony in favor of this procedure:

In your paper of December 6, 1877, there are three or four articles respecting the Hessian Fly, and they are so different from my observation of the wheat insect, as we call it here, that I send you a few lines respecting the damage done to wheat here. The last harvest was very much injured in some localities in this State; in the west part of Calhoun County on sandy land some pieces were not harvested, and others yielded from five to ten bushels per acre. In this part of Jackson County wheat did not suffer so much; some fields on bur-oak soil yielded as high as 35 bushels per acre of the Clawson variety.

The fly commences as soon as the wheat is up an inch high. I placed in a glass fruit jar some stools of wheat which were sown on the 31st of August, and about the 15th of October the fly hatched out of the brown eggs which were in the wheat in large

numbers, and was a lively little black fellow about one-eighth of an inch long. Now, if the eggs were deposited about the eighth of September, as that is as soon as the wheat would be large enough for them, it would give them about 37 days to mature so as to fly again, though they might hatch a little sooner or later in the open field. I cannot say as to that, having no certain means of knowing. Now if we wait till the first of October to seed we will be just in time for the first brood that comes out in the fall to deposit their eggs in the late sowing, which was the case hereabouts. Fields sown on the 25th of September, 1876, suffered more than that sowed on the 25th of August the same year, not three miles apart; the latter giving a good crop, and the former a very light one.

Now, my observation as well as practice is, that the earliest seeding is the best every time. There are a few farmers in the country who invariably sow early,—say as early as the 25th of August—and they hardly ever fail of a good crop. There may be a difference in varieties in resisting the ravages of the fly, and I presume there is. The Tappahannock suffered very much more than the Clawson in adjoining fields, on the same farms, and sowed about the same time. I venture the suggestion that we all sow our wheat earlier—say on the 20th of August, or soon after—as farmers used to do 50 years ago, so that our wheat will get a strong root and a large top to go into the winter with. I hope this suggestion will stir up some scientific man, like Professor Riley of Missouri, to investigate the habits of the fly as thoroughly as he has the locust or the Colorado potato beetle, for I think the country has suffered quite as much from the Hessian Fly as from all other pests put together. If this brings out the desired information, I shall be well paid for this my first contribution to your valuable paper, which I have read with great pleasure for the last ten years.

CALEB T. FULLER.

JACKSON COUNTY, MICHIGAN.

In reply to your request for information in regard to the Hessian Fly, I will state that only a few of the earliest sown pieces are affected in this and the adjoining county of Trimble. Wheat in general looks remarkably well, has tillered finely, and there is at least 15 per cent. more than an average acreage sown.

S. E. HAMPTON.

CARROLL COUNTY, KENTUCKY.

[Cultivator and Country Gentleman.]

We may, then, conclude that, on the whole, late sowing is the best general remedy, but still a part of the wheat should be sown early as a decoy to draw off the flies and induce them to lay their eggs in the early-sown grain, that the later sown portion may escape their attacks, and then farmers should plough under and resow the fields of early grain. Hence we indorse the following excellent advice, which was first suggested by Dr. Fitch, and reiterated by Professor Cook, as follows:

Let all, without exception, sow a narrow strip about each field, to be sown early in September, or even in August. From the fact that the flies are already in waiting, that the outer edge of a field is almost always the most injured, except that the field grew wheat that nourished flies the preceding year, and that such fields suffer most, one may expect this early-sown narrow rim to receive nearly all the eggs. Leave the balance of the field till we feel it is dangerous to wait longer, at least till after the middle of September, then sow it, after which plow deeply under the early-sown strip, that is if it is stocked with insects, which may be easily determined by examination, and resow it. We should thus kill two birds with one stone—save our crops, and destroy the pest.

Advantage of high culture.—Many farmers advocate high culture, sowing a less breadth of wheat, and cultivating the ground, using fertilizers. This is all-important, as the stronger and more luxuriant the growth of

the young wheat, the better able will it be to withstand the weakening effects of the maggots; while high culture will carry a partly infested field of wheat through, when the same grain grown on a poorer soil would succumb. The value, then, of good farming, conducted on scientific principles, the forcing of the plant by fertilizers, and the rotation of crops, is so self-evident that we need devote no more space to this subject, except to add the following remarks by practical farmers:

It is claimed by some that certain varieties of wheat are less liable to the attacks of the Hessian Fly, and entire exemption has been claimed for some. I am satisfied from experience that these claims are partially fallacious. There is no wheat which the fly will not injure under favorable conditions for its working. The supposed exemption is due to the fact, that when a weak-growing and strong-growing variety are sown side by side, the fly leaves the latter for the former. Whatever makes the wheat plant vigorous, helps to repel the attacks of all insect enemies. If the red sorts are less liable to injury, it is because their thicker and ranker leaves keep the plant too moist for the eggs and larvæ. I have seen the same result from the use of superphosphate, gypsum, salt, and in fact any manure which causes vigorous growth, with dampness. Coarse manure sometimes seems to favor the insect, but only, I imagine, when the weather is so dry that its coarse strawy substance is really more dry than the ground. Wherever the soil is moist, and wheat makes a rapid growth, the fly will do least damage. I shall take advantage of this fact, this fall, in fertilizing my wheat more liberally than ever before, using two hundred, or perhaps more pounds, of phosphate per acre, besides gypsum and salt to dilute it. If I can get a vigorous growth of wheat from the start, there will be less to fear from the fly. This liberal manuring will also enable me to defer sowing till later than would otherwise be safe.

Rolling and compacting the ground is very important as a means of keeping it moist. I shall not roll immediately after sowing, but wait until the wheat is up, when, if there is a dry time with no frosts to keep back the fly, I shall roll the ground with the hope that the roller will destroy at least some of the eggs which the fly may have laid.

W. J. F.

MONROE COUNTY, NEW YORK.

[*Cultivator and Country Gentleman.*]

In the rapidly increasing practice of extra manuring and cultivation of wheat, as by drilling and hoeing, it is found in very many cases that the Hessian Fly and other insects are far less troublesome than on the wheat fields where only ordinary cultivation is practiced. It frequently occurs, too, that superior cultivation permits of earlier sowing in the fall; the extra growth more than offsetting the damage done by the insects, to avoid which most farmers now are obliged to resort to late planting. Several examples are cited where drilled and cultivated fields, grown beside ordinary broadcast-sown and lightly-manured fields, with results wholly in favor of the former, the Hessian Fly greatly damaging if not totally destroying the latter, while the cultivated fields escaped almost unharmed.—[*Cultivator and Country Gentleman.*]

Pasturing with sheep.—Many farmers practice pasturing wheat fields with sheep or cattle; for it is claimed that if the wheat is strong enough by the middle or end of November to bear it, enough of the larvæ or flaxseeds may thus be destroyed to save the wheat and prevent the necessity of plowing it in. This is a rather rude, uncertain remedy, but can be carried on with more or less success in the Middle States. We give the opinions of those who have found pasturing successful.

From Mr. E. A. Hickman, of Independence, Mo., we obtain the following information:

In reply to your inquiry on the subject of the Hessian Fly, I will state that I have made some inquiry of our best wheat-raisers, and they report as follows: First, the wheat-

midge is not found in our State, hence is not further alluded to. A. L. H. Crenshaw, now an old wheat-raiser and quite successful, says he breaks up his ground in July and lets it lie till September, then harrows it into good planting condition and lets it remain until after a *killing frost*, which is usually from the 25th September to the 5th of October, then he puts in the seed by drilling. He has never lost a crop or had one injured by the fly.

G. W. Compton is a successful raiser; he breaks up in July, and by the 1st of September sows his wheat immediately, and as soon as the wheat is up and of sufficient height he turns sheep and other stock on it to keep it eaten down so that the fly can not shelter under its leaves. This has protected his crop until the fall of 1877, when the rains favored the breaking up of the ground and the planting and growing of the wheat to such an extent that the stock could not graze it down. Its rankness protected the fly and its abundance nearly destroyed his crops. He attributes his failure to the fact that his crop was not grazed sufficiently close.

Mr. James Lobb sowed early in September, 1878, a fine growing season; brought up a luxuriant and vigorous stand; no pasturing was applied either in fall or spring, and the crop only yielded about four bushels per acre, the balance being destroyed by the fly. This was adjoining a field that produced a fine crop, but cultivated to thwart the fly.

Two other successful men say they have followed the advice of an old settler, who told them to have everything ready, but never sow until after a *killing frost*; and they never suffer from that enemy.

Mr. Robert McNeilly, of Charlotte, Dickson County, Tennessee, writes us that "the best preventive found here is to pasture the wheat close in the winter with sheep."

We also reprint the following newspaper articles:

Another error is that pasturing will do no good. If sheep enough are turned in to eat the wheat down close before the eggs hatch, after being laid, very much good will result. This is an old remedy, and has proved very effectual in many instances. It is now too late to employ it, as the eggs are mostly hatched. During the fine weather of this fall, so far, very few days only were required to hatch the eggs, after which nothing could be done. Very few eggs are placed too close to the ground to escape the teeth of sheep, and if enough of these animals could be turned on to eat the wheat off within three days after the flies appeared, very little damage would result. Frost now will not do much good except with fields that have been sown late, where the blades have not grown large enough to attract the fly. The destruction of the entire crop does not follow the appearance of the fly always. Unless very badly infested, if the soil is rich and the season favorable, a fair crop may result in spite of the fly. Of course, the crop is always injured to some extent. The best remedy, after the larvæ have hatched and found security in the crown of the plant, is to stimulate the ground as much as possible by the application of fertilizers.

We mentioned in last week's issue that the Hessian Fly appeared in Pennsylvania as well as in Canada and other sections last year. It appears that the practice of early sowing has lately increased so much in Pennsylvania as to furnish everywhere the young winter wheat at exactly the time when the Hessian Fly is laying its eggs. This probably has a good deal to do with the trouble in Canada also. And yet the evils of late sowing are so great that most farmers would prefer to risk the Hessians. A correspondent of the Germantown Telegraph, speaking from experience—for he says that he has never known his system to fail both to destroy the fly and to greatly benefit the crop—gives a useful hint. He says that if the land is strong, the eggs of the fly may all be destroyed and the crop greatly benefited in this manner: After frosts cease in the spring, and the grain is beginning to grow rapidly, and the ground has become so dry that tramping will not injure the crop, pasture off the grain down to the crown of the plants with sheep. This will remove all the eggs, and it will

cause the plants to tiller profusely, often five to seven to one, and all starting together will each enjoy equal facilities for growth and maturity, and the crop will be greatly improved and increased. If the soil lacks fertility, it is well to apply a proper amount of a proper fertilizer when the sheep are removed. If no salt has been applied to the land, no application will be more likely to pay so well as this, at the rate of twelve to twenty bushels per acre. This is well worth trying.—[*Canada Farmer*.]

Sowing of hardy varieties of wheat.—When the stalks and leaves of certain varieties of wheat are tough and hard, the stems coarse and silicious, and the plants “tiller” or throw out secondary shoots in a vigorous way, such varieties are naturally the most fly-proof and should be selected for sowing as winter wheat, while the less hardy and vigorous kinds should be sown when the attacks of the Hessian Fly are not to be expected.

Of the different varieties of “fly-proof” wheat, the Underhill variety has for nearly a century been highly recommended. As Fitch remarks, its fly-proof qualities were supposed by many to be due to the hardness or solidity of its straw. The fly laid its eggs freely upon the leaves, but it was seldom if ever materially injured by it. It is a bearded white chaff, with a plump yellow berry, requiring to be thoroughly dried before grinding, and then producing flour in quantity and quality equal to the best of the other varieties.

The Mediterranean wheat is, in the Middle States, in high repute for its fly-proof and hardy nature, recovering better than other varieties from the attacks of the fly. A correspondent in Charlotte, Tenn., writes us that “the Mediterranean, Red Chaff, and Red May are less liable to be damaged by the fly than any we have tried.” Fitch says the Mediterranean wheat is a slight red chaff, having a long, stiff beard, a long, red, and very flinty berry, and ripens about ten days earlier than other varieties. In Central New York the Lancaster, a red variety, is strongly urged.

In Michigan the Clawson is apparently the favorite wheat, on account of its “fly-proof” qualities. As stated by Professor Cook—

The fact that last summer (1876), as well as this, when Diehl and Clawson were sown side by side, Clawson was comparatively free from insects, and, as stated by Mr. Rowe, did not break down in summer, seems to show that it is more exempt from attack. It would seem that the insects have a preference, but will accept plain fare rather than starve or fail to produce. It also seems clear that Clawson, Lancaster, and the red varieties will stand attacks with far less damage, owing to their vigor and greater tendency to sprout.

He then gives the following advice:

If wheat must be sown early, so long as the Hessian Fly remains a pest, by all means sow Fultz or other varieties of red wheat, or, better still, Clawson. But if we act more wisely still, and set the trap of an early-sown strip, let this be sown to Diehl, the better to attract the flies, and then, when we sow the balance of our field, two or three weeks later, sow Clawson or other rapid, vigorous growing varieties, which not only resist attacks better, but survive better when attacked. Lastly, if the early-sown area is harboring the pests, convert it into an insect cemetery, using the insects to fertilize a still further crop of Clawson.

Mr. W. L. Devereux, of Clyde, N. Y., gives us his experience with the fly and the best varieties to sow:

Now, concerning the fly: It is the least to be feared of all the injurious insects of the United States. I am situated in or just north of the starting point of the *Cecidomyia destructor* in this last crusade on wheat, which is Seneca and Tompkins Counties, New York, between Cayuga and Seneca Lakes. This section is also where the *Clawson* wheat originated, and I hold that the *Clawson* has been the propagator of the fly in this last spread. Perhaps the Soules helped the spread prior to this.

To my knowledge, there isn't a single instance of a field of Lancaster being injured by the larvæ of the fly. Indeed, I never could find a single larva or pupa in a field of Lancaster. It is the kind which farmers have sown almost entirely throughout this section this year. It does well, and, although a red wheat, it now commands as high if not higher price than *Clawson*.

I would particularly impress upon you the fact that we think the fly cannot be found on Lancaster wheat. It is a variety which is extremely tough and hardy, having that green color which farmers call "black," while the *Clawson* and similar wheats have a green color which is very often yellow. The Lancaster—to strongly indicate its toughness—is said to grow readily under water or on a rock. I have no personal motives in writing thus of the Lancaster wheat; I only want to indicate that it is too tough fiber for the Hessian Fly to live on. It is nearly like or is the *Blue-stem wheat*.

Professor Cook ranks the *Clawson* as being less injured by the fly than the Lancaster, but I think the latter is absolutely free from the fly, while the *Clawson* is literally eaten up alive by the fly.

Mr. Devereaux afterwards wrote as follows, under date of October 29, 1879:

The Hessian Fly has not destroyed wheat to any great extent this year. However, all white wheat suffered from the attacks of the fly, but still not to the extent it did last year. Red wheat has never been attacked (*vide* my article in *Rural New Yorker*, June 15, 1878). The principal bearded red wheat sown in this locality is called the Lancaster. An amber wheat called Fultz (a bald wheat) seems to be proof against the fly. Mold's red wheat (bald) is also not attacked. But the *Clawson* (white), so extensively sown here and elsewhere, was most severely attacked in 1877, very badly in 1878, and this year it was thought to be free from the fly, but when harvest came it was noticeably short, many heads unfilled, many stunted in their height. At this date of writing every piece of *Clawson* sown this fall is being ravaged (however, there are only a few pieces of *Clawson* for miles around here), the Lancaster, as heretofore, remaining uninjured.

I notice after harvest long stubbles and straws of wheat in field and barn-yard which have many little pin-holes from which the imago *Cecidomyia* escaped. Barley was damaged to an enormous extent last year, whole fields having nearly every straw so badly damaged that they would break off readily by passing through with the horse-rake, throwing it into winrows. This year barley was not hurt much.

Now, wasn't the great spread of the Hessian Fly, which occurred many years ago, brought about at that time by that extensively sown wheat, the *Soules*, which was a very similar wheat to the *Clawson*, which brought the fly this time? Or rather, each kind of these wheats, by their tender foliage and loose culms, allowed the rapid propagation of the fly, being their favorite variety of wheat; we may also add the fact that these wheats were popular among the farmers everywhere; thus whole wheat districts were sown entirely to this wheat, bringing forth countless numbers of the Hessian Fly to every acre. In the former spread of the fly, farmers entirely desisted from raising wheat, or resorted to red or Mediterranean wheat, and so the pests can be driven back now to their less prosperous plants by the sowing of Lancaster and similar wheats.

In conclusion, we may urge that whatever kind of wheat is used, much more depends on a rich soil, a vigorous growth, and careful cultivation, all of which tend to make the stalk stouter, the growth a few days earlier, than the choice of particular varieties.

SPECIAL REMEDIES.

Under this head belong the use of lime, dusted on the young wheat, rolling, deep plowing, burning the stubble after harvest, &c. Such special remedies as these are of little use as compared with careful preparation of the ground and late sowing, and some of them actually do more harm than good, as we shall see further on.

Application of lime to kill the maggot or larvæ.—It has been frequently recommended to spread fine lime, soot, or salt upon the young wheat so as to kill the young larvæ. As a sample of such treatment, which at least can do no harm, we extract the following statement from the *Kansas Farmer*:

The farmer who recommends the remedy is a Virginian, and he writes to a local paper as follows:

"I hear there is much 'fly' in the wheat that was sown early this fall. To correct this evil I offer the following remedy, which I and others have successfully tested for a good many seasons: Sow of air-slacked or water-slacked lime one or two bushels per acre broadcast over the wheat in the early morning on the dew, or over night on a clear evening, when there is reason to expect dew or frost. As it dissolves it will form a lye which will follow the leaf towards the root and destroy the chrysalis of the fly near that point.

"The sower must always sow with the wind, else the lime will be blown back in his face and eyes and on his clothes. And he must grease his hands, face, and nostrils with lard, which renders contact with the lime innocuous. If two or more sow they should sow *en echelon*, at such a distance that the rear shall cast no lime on the front. A very good but not indispensable plan is to use tea scoops—diminutive sugar scoops—that will hold a double handfull. It enables one better to take up and measure the quantity to be applied. This is an application so simple and cheap as to discredit it with the many who are often looking to be told 'some great thing.' I can only say that I know it to be effectual as a remedy, and that in no case can it do harm."

It is evident that such remedies as these should be applied before the insect transforms into the flaxseed state, as the hard, dense pupa case is impervious to ordinary appliances such as would kill the maggots.

Rolling the ground to kill the larvæ and flaxseeds.—Practical men advise rolling the ground both to keep it moist and in order to destroy the eggs, larvæ, and some of the flaxseeds. This may be in some cases worth trying, but we should think that full as much injury would be done to the wheat plants as to the minute larvæ and eggs upon them.

Cutting the grain close to the ground.—This has been sometimes practiced. A writer in the *Ohio Farmer* makes the following statement in favor of this plan:

E. C. Green, Medina County, Ohio, writes: "The Hessian Fly appeared in this vicinity, but has done but little damage. The wheat commenced to fall over before it was cut, and the eggs or larvæ were found above the first or second joint. The damage on five acres of wheat was probably five or six bushels. By reaping low and raking the stubble was all saved."

A serious objection to reaping low is that many insects of the summer brood in the flaxseed state are, as Mr. S. S. Rathvon claims, carried to the barn or stack, beyond the reach of remedy. From the straw thus har-

vested the fly would emerge before it was threshed, "and might even pass through a machine without injury". In this manner the fly has possibly been distributed through different sections of the country.

Burning the stubble.—Although this remedy has been advocated, it will be seen to be worse than useless when we reflect that after all the artificial means taken to reduce the number of the Hessian Fly, nature's method of checking its undue increase is far more important and thorough-going; we refer to the diffusion and multiplication of the insect-parasites. As previously stated, most probably nine-tenths of the young Hessian Flies are destroyed in the larva or pupa state by the parasites already described. For the most part these parasites live in the flaxseeds contained in the straw, and appear in spring. Now, to burn the stubble in the autumn or early spring is simply to destroy these useful parasites, the best friends of the farmer. We do not hesitate to urge that the straw be untouched. On the contrary, the parasites should be gathered and bred in numbers; and we believe that practical entomologists should bend all their energies towards clearing up the subject of rearing and multiplying these insect hosts. Much knowledge and practical skill is needed in this direction, as occasionally by disseminating the parasites their noxious hosts may increase and be distributed; but knowing, as we do, how many more of the parasites are in many cases bred than the insects on which they prey, it seems safe and reasonable to advise not only not burning the stubble, but letting it stand, so that the parasites may finish their transformations, become fledged, and ready, when the eggs and larvae of the Hessian Fly are upon or in the young wheat, to destroy them.

It is a matter of fact that in years when the Hessian Fly is specially abundant and destructive, similar seasons are highly favorable to the corresponding increase in the number of their insect or ichneumon parasites; they do their work so effectively that the few following years the numbers of Hessian Flies are greatly reduced. It is, then, to these parasites that we are indebted for the years of immunity from the attacks of the Hessian Fly, as much as to favorable or unfavorable weather, and this leads us to consider the apparent *periodicity* in the years of abundance and scarcity of the Hessian Fly.

PERIODICITY IN THE ABUNDANCE AND SCARCITY OF THE HESSIAN FLY.

The following tabular view, though constructed from very scanty and often misleading data, may throw some light on this subject. All insects, especially the more noxious ones, those which fall under common observation, such as the locust, cotton-worm, army worm, chinch-bug, and the like, have their years of undue numerical increase and of unusual scarcity. This periodicity is, without doubt, partly owing to the influence of the weather, of favorable and unfavorable seasons, and partly, in most cases,

to the absence or abundance of the insect parasites, although the latter cause is largely influenced by climatic agencies.

The table has been drawn up from the reports of Fitch, Hind, Cook, and of the Agricultural Department at Washington, and from different newspapers, as well as from private correspondence. The record, as therein presented, is very imperfect, but still is sufficient to show the periodicity in the return of periods when the Hessian Fly has been sufficiently abundant to ravage wheat-fields and excite apprehension and alarm. Without much doubt, in the different States mentioned, especially in the Middle States, the insect is tolerably abundant nearly every year, but few seasons occurring when after a careful search by experts the fly would not be found.

As the recorded facts indicate, within about ninety years there have been, in the Atlantic and Middle States, six periods of unusual abundance, namely, centering about the years 1790, 1817, 1844-'45, 1871-'72, and 1876-'78. These dates, which generally are inserted in larger type in the table, mark the time of culmination in the degree of abundance and extent of ravages committed, and were preceded by from one to several years of less or greater abundance. After the culmination, or year of greatest abundance, the fly often suddenly disappears. This sudden disappearance is, without doubt, due to the great increase in the number of parasites, while the original increase is probably due to a succession of warm, damp seasons, favorable to the multiplication of the flies. These seasons, when we look at the later Hessian Fly years, such as 1844-'45, 1871-'72, and 1876-'78, when the insect had become widespread over the western portion of the wheat area, were evidently areas of similar climatic features common to the Atlantic and Mississippi Valley States. Whether these seasons were warm and moist or not, we have not the means at hand to enable us to form an opinion. We simply at this time draw attention to the great desirability of putting on record the amount of correspondence between the meteorological conditions of the seasons of undue increase or unusual scarcity of insect pests, in order that we may be able in the future to make some calculations as to their probable increase or decrease, that farmers and gardeners may govern themselves accordingly.

As stated to us by Mr. Thomas, in 1817, the rainfall from Maine to Maryland was slightly above the average, 1.01 per cent. of the mean.

The winter of 1843-'44 was the most severe in the West that had been experienced for twenty years; the spring was cold and late; 1844 was very wet over the West, in fact the wettest season known since its settlement, or at least since 1811. This was the year of the great flood in the Mississippi. It was also wet in parts of Virginia and Maryland. But along the sea-coast from Maine to Florida the amount of rainfall was only about .90 per cent. of the mean. In 1845 it was not very wet in any section where wheat was cultivated, the amount along the sea-

coast being placed at .95, and this was about the same in the Middle and Northwestern States, varying from .83 to .91 per cent. of the mean.

We thus see that the Hessian-Fly years, 1817 and 1844, were wet years, periods of more than the average rainfall. Of 1871 we have no records at hand; the spring and summer of 1877 were damp and wet, and, also, appear to have been warmer than the previous year. There thus appears to be a correlation between the seasons of greatest abundance of Hessian Flies and a greater degree of moisture, if not of heat.

3 II F

Chronological table of Hessian-

New York.	New Jersey.	Pennsylvania.	Delaware.	Maryland.	Virginia.	West Virginia.	Connecticut.	North Carolina.	South Carolina.	Ohio.	Indiana.	Illinois.
1778												
1778												
1780												
1781												
1782												
1783												
1784												
1785												
1786	1786	1786										
1787	1787	1787										
1788	1788	1788										
1789		1789										
1790	1790	1790		1790								
1791			1791									
1792			1792									
1793												
1794												
1795												
1796												
1797		1797								*1797		
1798												
1799												
1800												
1801					1801							
1802					1802							
1803					1803							
1804					1804							
1810												
1817		1817		1817	1817							
1820		1820		1820								
1831												
1835	1835	1835		1835	1835		1833					
1836	1836	1836		1836	1836							
1840		1840		1840	1840		1837	1840		1840		
1841		1841		1841	1841		1840			1841		
1842		1842		1842	1842					1842		
1843		1843		1843	1843					1843		
1844		1844		1844						1844	1844	1844
1845		1845		1845						1845		1845
1846		1846		1846	1846					1846		1846
1847											1847	1847
1849										1849		
		1850			1850					1850		
		1851			1851					1851		
					1852							
1854		1853										
		1854										
											1861	1861
			1860	1860						1860		
1871	1871	1871		1871	1871	1871		1871	1871	1871	1870	1871
	1872	1872		1872	1872	1872		1872		1872	1872	1872
	1873		1873	1873	1873	1873					1873	1873
		1874		1874						1874		
										1875		1875
		1876		1876	1876			1876		1876	1877	1877
1877		1877						1877		1877	1877	1877
1878								1878		1878		1878
1879			1879					1879		1879		1879

*Ap. eared west of

DISTRIBUTION OF THE HESSIAN FLY.

There is little doubt but that this insect was, as stated first by Col. George Morgan, of Prospect, N. J., and afterwards by Mr. Herrick and Dr. Fitch, introduced from Europe. That it was originally a European insect is shown by Mr. Herrick,* who quotes a writer as authority for the statement that the insect was injurious to wheat near Geneva, in May, 1732, and again in May, 1755. It was also detected by Prof. J. D. Dana, in the spring of 1834, who found the larvæ, pupæ, and reared the flies from wheat growing on the island of Minorca. He sent several pupæ and flies from Mahon to Mr. Herrick, who identified them as the Hessian Fly. As he writes, "the Mahonese asserted that the insect had been there from time immemorial, and often did great damage both there and in Spain." Dana also collected the same insect at Naples, and also at Toulon, France. It seems, also, that this insect, or one very closely allied to it, injured the wheat in Hungary at or about the same date as Mr. Dana's visit to Europe, *i. e.*, 1834.

Like some other insects introduced from Europe, which there are only slightly injurious, the *Cecidomyia destructor* here became *prepotent*, *i. e.*, multiplied to an unusual degree, and became alarmingly prevalent, while in Europe it had not been even described by entomologists, its local ravages having been mostly confined to areas not visited, apparently, by entomological students.

With Herrick, Fitch, and others, we are disposed to credit the belief of Colonel Morgan, that this fly was introduced into America in the straw used for packing, brought by the Hessian troops during the Revolutionary war. These troops were landed on Staten and the west end of Long Island, August, 1776. This, then, was the starting-point from which the fly originated, and it will be interesting to learn how it spread to its present limits, how rapidly, and whether it is at all migratory. Our knowledge on these points will be mainly derived from Fitch's report and subsequent publications.

By reference to the foregoing chronological table of the years when the Hessian Fly was prevalent and injurious, one can comprehend easily the rapidity of distribution and the States successively invaded by it. The States are arranged as nearly as possible in the order in which they were first visited.

In his interesting history of the introduction of the fly into this coun-

* In the *Elements d'Agriculture*, par Duhamel du Monceau, Paris, 1771, 2 tomes, 12 mo., is a statement from M. de Châteauneux, of which the following is a translation: "Our wheat [in the neighborhood of Geneva] has sustained, the present month of May, 1755, an injury from which the grain cultivated by the new husbandry has not been exempt. We found upon it a number of small white worms, which eventually turned to a chestnut color; they fix themselves within the leaves and gnaw the stalks; they are commonly found between the first joint and the root; the stalks on which they fasten grow no more; they become yellow and dry up. We suffered the same injury in 1732, when these insects appeared in the middle of May, and did such damage that the crops were almost annihilated," i, 299. The Hessian Fly and its parasites, by E. C. Herrick, *Amer. Jour. Sc.*, p. 153, 1841). The chestnut-colored worms mentioned by this writer are evidently the "flaxseed" of the Hessian Fly, as no other wheat insect has such a pupa case.

try, Dr. Fitch shows that in August, 1776, Lord Howe's army, partly on Staten Island and partly at Flatbush, on Long Island, was strongly reinforced by Hessians and Waldeckers, most of whom were from Hesse Cassel, "a district but about a hundred miles distant from Saxe-Coburg and Saxe-Altenburg, where, as we have already seen, the same insect did much damage to the wheat crops in 1833."*

At Long Island, then, as shown by Dr. Fitch, the Hessian Fly originated, and from this point gradually spread over the wheat area of the colonies, and afterwards of the United States, enlarging its limits of distribution with the corresponding increase in the extent of the wheat area of our country.

It spread more rapidly at first towards the eastward, nearly to the end of Long Island and to Shelter Island. As Havens remarks, "It was first perceived a little before harvest, and appeared to have come from the west end of Long Island in a gradual progress of between twenty and thirty miles a year."

In ten years after its importation into America it reached Prospect, N. J., about forty miles southwest of Staten Island, and in 1788 it was noticed at Trenton, N. J., and in Pennsylvania. Undoubtedly, had there been railroads at that time, with the rapid transit of grain-cars and bales of hay and straw, it would have spread at least with three times the rapidity of its recorded rate of diffusion.

In 1789 the fly first reached Saratoga, a point situated 200 miles north of its original point of departure. "The insect reached here by a regular progress from the south, coming nearer and nearer each successive year."

It appeared west of the Alleghanies in 1797, though in what state we are unable to learn, while Virginia was invaded in 1801, and North Carolina about the year 1840. Westward its progress brought it to Ohio in 1840, and three years later it was detected in Michigan. In 1844 it was destructive in Ohio, Indiana, Illinois, Michigan, Wisconsin, and the eastern border of Iowa, while it was common in the Middle Atlantic States, and became destructive in Northern Georgia in 1845. Meanwhile it had reached Western Canada in 1805. North of Connecticut it seems to have existed only sporadically, and to have maintained only a temporary foothold in Vermont and Maine in 1850-'52, and has never been noticed in New Hampshire or in Massachusetts. Minnesota was visited in 1860, and probably earlier.

It must have reached Missouri, Arkansas, and Texas long previous to the date given in our table, but probably the year it entered Eastern

* Sir Joseph Banks drew up a report on this insect for the Privy Council, dated March 12, 1789. He states that "since its first appearance in Long Island it has advanced at the rate of fifteen or twenty miles a year, and neither waters nor mountains have impeded its progress. It was seen crossing the Delaware like a cloud from the Falls Township to Wakefield; had reached Saratoga, 200 miles from its first appearance, infesting the counties of Middlesex, Somerset, Huntington, Morris, Sussex, the neighborhood of Philadelphia, all the wheat counties of Connecticut, &c., committing the most dreadful ravages, attacking wheat, rye, barley, and timothy grass. The Americans who have suffered by this insect speak of it in terms of the greatest horror."—Dobson's Encyclopedia, viii, art. Hessian Fly.

Kansas (1871-'72) is not much posterior to its arrival there, and this is at present its most westernmost limit. No traces of it, so far as we can learn, have been seen in Nebraska. (Compare the map at the end.)

Does the Hessian Fly migrate?—As regards the so-called migrations of this insect, we would express our disbelief in any such movement from place to place as is involved in the idea of the word migration. The history of the insect simply shows that it has steadily spread from its original point of introduction to new sections of the country as rapidly as they were settled and wheat became a staple article of production. It is periodically abundant, much as most other obnoxious insects are, more abundant some years than others; becoming abundant at some localities and scarce at others. It cannot, therefore, truly be said to "migrate" from one part of a State to another, or from one natural region to another.

Probable limits of the Hessian Fly.—The question naturally arises whether this pest will ever infest the wheat regions of Western Dakota, Montana, Utah, Colorado, and the Pacific States and Territories. We believe not, though aware that such a statement may be hazardous. It was originally an inhabitant of Central and Southern Europe; it has become acclimated in the Eastern Atlantic and Middle States, in the valley of the Upper Saint Lawrence, and in the valley of the Mississippi River; that it can thrive in the elevated, dry Rocky Mountain plateau region, and withstand the cool nights and dry, hot atmosphere of the Far West, seems very doubtful. At least, so slowly has it spread westward, so slight an amount of wheat or straw is transported westward, all produce of this kind going eastward, that we doubt whether, during this century at least, it will extend west of Kansas and Minnesota, where it has already had a foothold for several years.

SUMMARY OF THE HABITS OF AND REMEDIES AGAINST THE HESSIAN FLY.

1. There are two broods of the fly, the first laying their eggs on the leaves of the young wheat from early April till the end of May, the time varying with the latitude and weather; the second brood appearing during August and the early part of September, and laying about thirty eggs on the leaves of the young winter wheat.

2. The eggs hatch in about four days after they are laid. Several of the maggots or larvæ make their way down to the sheathing base of the leaf, and remain between the base of the leaves and the stem near the roots, causing the stalk to swell and the plant to turn yellow and die. By the end of November, or from thirty to forty days after the wheat is sown, they assume the "flaxseed" state, and may, on removing the lower leaves, be found as little brown, oval, cylindrical, smooth bodies, a little smaller than grains of rice. They remain in the wheat until during warm weather; in April the larva rapidly transforms into the pupa within its flaxseed skin, the fly emerging from the flaxseed case about

the end of April. The eggs laid by this first or spring brood of flies soon hatch; the second brood of maggots live but a few weeks, the flaxseed state is soon undergone, and the autumn or second brood of flies appear in August. (In some cases there may be two autumn broods, the earliest August brood giving rise to a third set of flies in September.)

3. There are several destructive ichneumon parasites of the Hessian Fly, whose combined attacks are supposed at times to destroy about nine-tenths of all the flies hatched. Of these, the most important is the Chalcid four-winged fly (*Semiotellus destructor*, Plate 1, fig. i, much enlarged), which infests the flaxseed; and the egg-parasite (*Platygaster*, fig. 1).

4. By sowing a part of the wheat early, and if affected by the fly, plowing and sowing the rest after September 20, the wheat crop may in most cases be saved. It should be remembered that the *first* brood should be thus circumvented or destroyed in order that a second, or spring, brood may not appear.

5. If the wheat be only partially affected, it may be saved by fertilizers and careful cultivation; or a badly damaged field of winter wheat may thus be recuperated in the spring.

6. Pasturing with sheep, and consequent close cropping of the winter wheat in November and early December, may cause many of the eggs, larvæ, and flaxseeds to be destroyed; also, rolling the ground may have nearly the same effect.

7. Sowing hardy varieties. The Underhill Mediterranean wheat, and especially the Lancaster variety, which tillers vigorously, should be sown in preference to the slighter, less vigorous kinds in a region much infested by the fly. The early (August) sown wheat might be Diehl; the late sown, Lancaster or Clawson.

8. Of special remedies, the use of lime, soot, or salt may be recommended, also raking off the stubble; but too close cutting of the wheat and burning the stubble are of doubtful use, as this destroys the useful parasites as well as the flies.

FURTHER INFORMATION DESIRED.

What has been stated in the foregoing pages has been mostly compiled from the observations of others, though all the members of the commission have paid more or less attention to this pest in former years.

In order that a more detailed, valuable report may be made as to the habits, distribution, remedies, and statistics of losses, all necessary for a full and satisfactory treatment of the subject, answers to the following topics from wheat-growers in the United States, especially in the South and West, are earnestly desired. The publications of the commission will be sent free to all persons who will kindly send replies and specimens to the following questions; and postage and all necessary expenses will be paid to those sending specimens of this or any other insects in-

festing wheat, barley, oats, and rye. The writer may be addressed at Providence, R. I.

1. At what date is the "flaxseed" state of the Hessian Fly assumed?
2. At what date does the fly appear in spring and autumn?
3. During what year did the Hessian Fly first appear to do damage in your neighborhood, and how was it introduced?
4. How many "broods" or generations are observed annually—more than two? and when does the plant suffer most, in spring or autumn?
5. State what you know of the relative immunity or susceptibility of different varieties of wheat, and upon what other cereals or grasses the insect is known to develop.
6. What kind of weather favors its injuries, and what meteorological conditions prevent them? Was the season of greatest abundance a wet or dry one?
7. Look for minute parasites in the eggs and maggots and flaxseed. They may be bred by placing the eggs and maggots with the wheat in bottles covered with paper, or even loosely corked, and the parasitic flies preserved in vials of alcohol.
8. Give statistics as to abundance and losses in your town or county.
9. State the best preventive remedies, as high culture, the rotation of crops, pasturing to sheep or cattle, rolling, &c.

Specimens of the wheat affected by these insects, and of the eggs, maggots, and flies, together with their parasites, in alcohol, are requested. When mailed, the alcohol can be poured out, and cotton soaked in alcohol will keep the specimens wet until received. Packed in a tin box they can be sent through the mail.

APPENDIX.

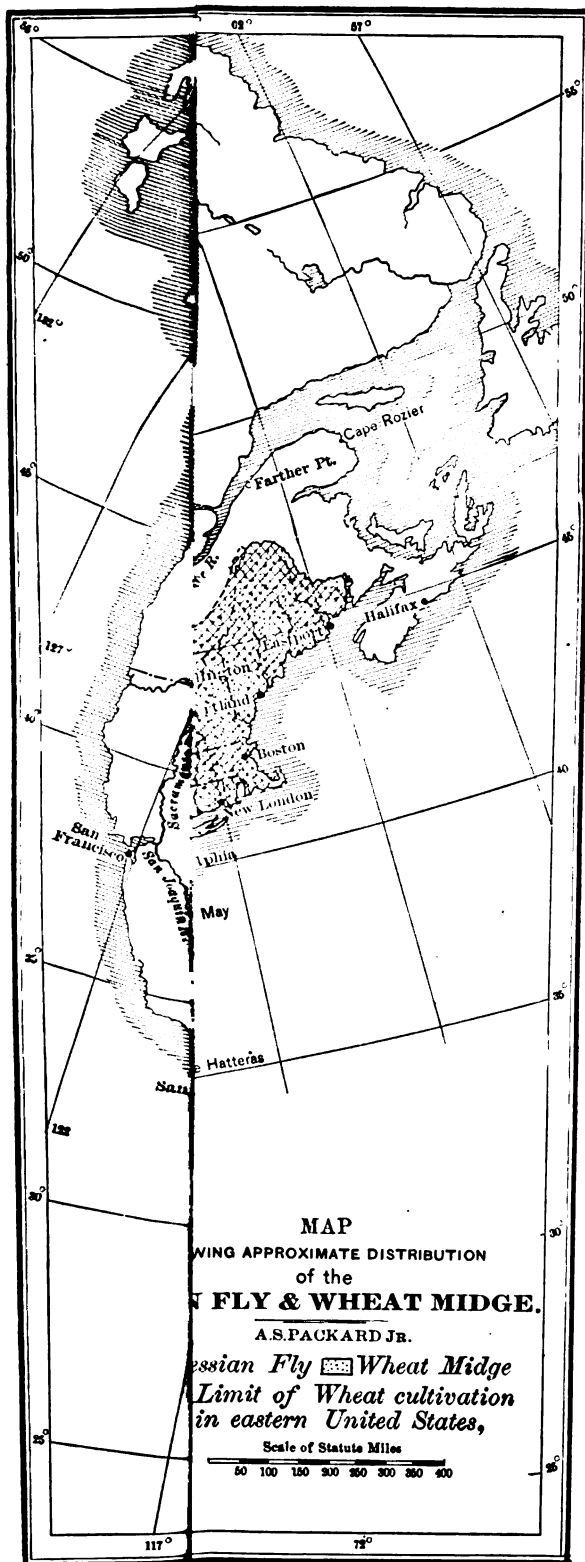
LIST OF WORKS AND ARTICLES RELATING TO THE HESSIAN FLY.

The following list embraces the most important writings relating to the Hessian Fly. The title of many of them are taken from Fitch's report and the bibliographical list in Bergenstamm and Loew's *Synopsis Cecidomyidarum*.

- DUHAMEL. *Éléments d'Agriculture*. Par Duhamel du Monceau. Paris, 1771, i, p. 229.
- MORGAN, GEORGE. *Pennsylvania Mercury*, June 8, Sept. 14, 1787.
- CLARK, THOMAS. *Pennsylvania Mercury*, Sept. 14, 1787.
- Vaux and JACOBS. *Philadelphia Packet*, Aug. 21, 1788.
- HAVENS. Observations on the Hessian Fly. By Jonathan N. Havens. *Transactions of the New York Society for the Promotion of Agriculture, Arts, and Manufactures*, 1792. Second edition 1801, pp. 71-86.
- CHAPMAN, DR. ISAAC. *Memoirs of the Philadelphia Society for Promoting Agriculture*, v, 1797.
- ENCYCLOPÆDIA BRITANNICA, viii. Article Hessian Fly, pp. 489-495, 1797.
- DOBSON. *Encyclopædia; or a Dictionary of Arts and Sciences and Miscellaneous Literature*. Article Hessian Fly. Published by Thomas Dobson. 21 vols. Philadelphia, 1798-1803. viii, p. 489-495, 1798.
- MITCHELL. *Encyclopædia Britannica*. Address in. *Transactions of the New York Society of Agriculture*, i, p. 32. Article in *Medical Repository*, vii, p. 97, 1803.
- ANONYMOUS. Carey's American Museum, Phila., i, pp. 143, 324-326, 1786; iv, p. 47, 1788; xi, pp. 285, 301, 1792.
- McLELLAN. Article in *American Farmer*, by H. McLellan, ii, p. 234, 1804.
- KIRBY and SPENCE. *An Introduction to Entomology*. By W. Kirby and W. Spence. 1815-'26, i, p. 50.
- BOSE. Quelques aperçus sur l'insecte connu sous le nom de Mouche Hessoise, et sur un insecte parasite qui s'en nourrit. Par L. A. G. Bose d'Antic. *Annales de l'Agricult. France*. Tom. 70, 1817, pp. 277-303.
- SAY. Some account of the insect known by the name of Hessian Fly, and of a parasitic insect that feeds on it. By Thomas Say. *Journal of the Academy of Natural Sciences*, i, pp. 45-48, with a plate, 1817. See also *Magazine of Natural History*, vol. i. (Kirby).
- ANONYMOUS. An account of the wheat insect of America, or the *Tipula vaginalis tritici*, commonly called the Hessian Fly. *American Monthly Magazine and Critical Review*, August, 1817, New York, i, pp. 275-279.
- COCKE. Address by John H. Cocke to Albemarle Agricultural Society of Virginia, 1817.
- MERRIWEATHER. Articles, by Dr. Merriweather and others, in the *Richmond Inquirer*, *National Intelligencer*, and *American Farmer*, 1817 *et seq.*
- GARNETT. Article by James M. Garnett in the *American Farmer*, ii, p. 174, 1820.
- TILGHMAN. Article by Edward Tilghman in the *American Farmer*, ii, p. 235, 1820. Also in *Cultivator*, viii, p. 82, May, 1841.
- WORTH. Article by James Worth in *American Farmer*, ii, p. 180, 1820.
- HICKOK. Essay by Judge Hickok in *Memoirs of the New York Board of Agriculture*, pp. 169-171, 1823.
- BIRNIE. On the efficacy of certain steps to preserve wheat from the fly and smut (Hessian Fly). By C. Birnie. *New England Farmer*, iii, p. 171, 1824.
- BUEL. Paper by Judge Buel in the *Memoirs of the New York Board of Agriculture*, iii, pp. 323-338, 1826.
- WESTWOOD. Article *Cecidomyia*, by J. O. Westwood, in *British Cyclopædia of Natural History*.
- KOLLAR. *Naturgeschichte der schädlichen Insecten in Bezug auf Landwirthschaft und Forstkultur*. Wien, 1837. English translation by J. and M. London, with notes by J. O. Westwood. London, 1840, pp. 118-123.
- MORRIS. On the *Cecidomyia destructor*, or Hessian Fly. By Margaretta H. Morris. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1841, pp. 66-68; iii, 1847, p. 238; iv, 1849, p. 134. *Transactions of the American Phil. Society of Philadelphia*, ser. 2, viii, 1843, pp. 49-51.

- COATES. Remarks on the Present State of the Evidence in Regard to the Hessian Fly. By Benjamin H. Coates, M. D. 1841.
- . Note on the natural alliances of the genus *Cecidomyia*, intended to facilitate identification. By B. H. Coates. Proceedings Acad. Nat. Sci. Phila. 1842, i, pp. 191-192.
- . On some larvæ in wheat stalks. By B. H. Coates. Proceedings Acad. Nat. Sci. Phila., 1842, i, pp. 45, 54-57.
- BERGEN. Remarks on the Hessian Fly. By Garret Bergen. Cultivator, viii. Albany, Aug., 1841.
- HERRICK. A brief preliminary account of the Hessian Fly and its parasites. By Edward C. Herrick. American Journal of Science and Arts, xli, Oct., 1841, New Haven, pp. 153-158.
- . Observations on the Hessian Fly. By E. C. Herrick. Report of the Commissioner of Patents for 1844, Washington, 1845, Appendix, pp. 161-167. See also letters to Dr. T. W. Harris in entomological correspondence of T. W. Harris, and the Connecticut Farmers' Gazette, No. 40.
- HARRIS. A Report on the Insects of Massachusetts Injurious to Vegetation. By Thaddeus W. Harris. Cambridge, 1841, pp. 421-433. Reprint, 1842. Second edition, Boston, 1852. Third edition, with illustrations, 1862.
- . Article by T. W. Harris in New England Farmer, 1842, xx, pp. 409-410.
- . Entomological Correspondence of Thaddeus William Harris, M. D. Edited by Samuel H. Scudder. Occasional Papers of the Boston Society of Natural History, i, Boston, 1869, 8°, pp. 181-207.
- CURTIS. Observations, etc., including a saw fly, the Hessian Fly, the wheat midge, and the barley midge. By John Curtis. Journal of the Royal Agricultural Society of England, 1845, vi, pp. 131-156, pl. 1. Separately printed, London, 1845, 8°, p. 28, pl. 1.
- . Farm Insects. By John Curtis. London, 1860, p. 258.
- WESTWOOD. Article on the Hessian Fly. By John O. Westwood. Gardeners' Chronicle, London, 1847, p. 604.
- YUKES. Notice by J. D. Yukes. Patent Office Report, Washington, 1850.
- FITCH. The Hessian Fly; its history, character, transformations, and habits. By Asa Fitch, M. D. [originally published in the American Journal of Agriculture and Science, iv, v, 1845, and now revised by the author]. Transactions of the New York State Agricultural Society, vi, 1846, Albany; 1847, 8°, pp. 316-373, with a plate. Printed separately, Albany, 1846, 8°, p. 63, with a plate; and also Albany, 1847, 8°, p. 60, with a plate.
- . Seventh report on the noxious and other insects of the State of New York. By Asa Fitch, M. D. pp. 133-144, with a plate, 1862.
- MOTSCHULSKY. Article by Victor Motschulsky in Journal du Ministère de l'Intérieur, 1852.
- HIND. Essay on the Insects and Diseases Injurious to the Wheat Crops. By H. Y. Hind, Toronto, 1857, pp. 38-74.
- SICHEL. Article by Jules Sichel in Annales des Société Entomologique de France, 1856, iv, Bulletin, p. 8.
- LOEW. Über die den Roggen in den Prov. Schlesien und Posen vernüftende Fliegenmade. By H. Loew, in Zeitschrift Entomol. schles. Verein für Insektenkunde, 1858, xii.
- . Die neue Kornmade und die Mittel, welche gegen sie anzuwenden sind. Zullichan. Sporleder, 1859, 8°, p. 29.
- OSTEN SACKEN. Article by R. Von Osten Sacken in Stettin entomologische Zeitung, 1862, p. 80.
- HABERLANDT. Article by Haberlandt. Verhandlungen zool.-botan. Gesellschaft, Wien, 1864, p. 401.
- KÜNSTLER. Article by Künstler. Verhandlungen zool.-botan.-Gesellschaft. Wien, 1864, pp. 407, 779; 1871, p. 15.
- WALSH. Brief notices by B. D. Walsh, editor of the Practical Entomologist, 1867, pp. 10, 37.
- STIERLIN. Article by Stierlin in Mittheilungen der Schweiz. entomol. Gesellschaft, 1868, ii, p. 157.
- COHN. Untersuchungen über Insectenschaden auf den schlesischen Getreidefeldern im Sommer 1839, 1839, p. 12.
- KALTENBACH. Die Pflanzenfeinde aus der Klasse der Insekten. Stuttgart, 1874, pp. 734, 738, 741.
- RUDOW. Die Pflanzengallen Norddeutschlands und ihrer Erzeuger. 1875, p. 84.
- BERGENSTAMM and LOEW. Synopsis Cecidomyidarum. Von J. E. von Bergenstamm und Paul Loew. Aus den Verhandlungen der K. K. zoologisch-botanischen Gesellschaft in Wien, 1876, 8°, p. 104.
- PACKARD. Guide to the Study of Insects. By A. S. Packard, jr., M. D. 8°, first edition, 1868-'69, pp. 374-375, Salem, Mass. Second edition, 1870. Third edition

1872. Fourth edition, 1874. Fifth edition, 1876. Sixth edition, New York, 1878. Seventh edition, New York, 1880.
- . *Our Common Insects*. Salem and Boston, 1873, 12°, pp. 79, 196.
- . *Half Hours with Insects*. Boston, 1877, 12°, pp. 212-215.
- . *Report on the Rocky Mountain Locust and other Insects now injuring or likely to injure Field and Garden Crops in the Western States and Territories*. By A. S. Packard, jr., M. D. (Published in Report of the United States Geological Survey of the Territories, F. V. Hayden in charge, 1875.) Washington, 1877, pp. 695-697. Fifty extra copies with a separate title page. *The Injurious Insects of the West*. Salem, S. E. Cassino, 1877, 8°, pp. 589-815, this being the original pagination, with a map showing the distribution of the Hessian Fly.
- COOK. *The Hessian Fly*. A lecture by Prof. A. J. Cook. Michigan, 1878, 8°, p. 14.
- RILEY. Report of the Entomologist Charles V. Riley, M. A., Ph. D., August 22, 1879. (Author's edition, from the Annual Report of the Department of Agriculture for the year 1878.) Washington, 1879.
- . *Hessian Fly and Wheat Rust*. New York Weekly Tribune, Dec. 19, 1877.
- . *Fighting the Hessian Fly*. New York Weekly Tribune, Sept. 12, 1877.
- . *The Hessian Fly*. Saint Louis Illustrated Journal of Agriculture, June 14, 1877.
- HAGEN. *The probable Parthenogenesis of Cecidomyia destructor*. By Dr. H. Hagen, North American Entomologist, vol. 1, No. 9, March, 1880, p. 65, 66. (Noticed in American Entomologist, iii, p. 127.)



MAP
SHOWING APPROXIMATE DISTRIBUTION
of the
RUSSIAN FLY & WHEAT MIDGE.

A.S. PACKARD JR.

Russian Fly [dotted pattern] *Wheat Midge*
Limit of Wheat cultivation
in eastern United States,

Scale of Statute Miles
0 50 100 150 200 250 300 350 400

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 5.

THE CHINCH-BUG.

ITS HISTORY, CHARACTERS, AND HABITS, AND THE MEANS OF
DESTROYING IT OR COUNTERACTING ITS INJURIES.



I

By CYRUS THOMAS, Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1879.

C. V. RILEY, *Chief*,
Washington, D. C.

A. S. PACKARD, JR., *Secretary*,
Providence, R. I.

CYRUS THOMAS,
Disbursing Agent,
Carbondale, Ill.

LETTER OF TRANSMITTAL.

CARBONDALE, ILL., *December 6, 1879.*

DEAR SIR: I herewith submit to the Commission for publication the manuscript of the Bulletin I have prepared, according to the direction of the Commission, on the history, description, and habits of the chinch-bug, and the best means of destroying it or preventing its injuries.

Very respectfully,

CYRUS THOMAS.

Prof. C. V. RILEY,

Chief of United States Entomological Commission.

THE CHINCH-BUG.

The chinch-bug (*Blissus leucopterus* Say) is unquestionably one of the most formidable insect pests with which the farmers within the wheat-producing area of the United States have to contend. Although not exceeding a grain of wheat in size, rather slow motioned, and possessing no other weapon of destruction than its tiny slender beak, yet the species is enabled to make up by number for the lack of individual capacity for destruction.

The locusts of the west are the only creatures of this class "which exist within the bounds of our national domain, whose multiplication causes more sweeping destruction than does that of this diminutive and seemingly insignificant insect." In the territory east of the Mississippi it is without a rival.

Mr. Walsh estimated the loss from the ravages of this insect in Illinois alone, in 1850, at \$4,000,000, an average of \$4.70 to every man, woman, and child then living in the State.

Dr. Shimer says that it "attained the maximum of its development in the summer of 1864, in the extensive wheat and corn fields of the valley of the Mississippi, and in that single year three-fourths of the wheat and one-half of the corn crop were destroyed throughout many extensive districts, comprising almost the entire Northwest, with an estimated loss of more than \$100,000,000 in the currency that then prevailed."

Mr. Thomas, in his second report as State entomologist of Illinois, remarks as follows, in reference to the loss occasioned by them in 1871: "I find no complaints of damage recorded in 1870, but as the summer was dry over a large area, and they appeared in immense numbers in 1871, it is more than probable that they began to increase in the latter half of the season."

As Dr. Le Baron has noticed somewhat fully in his second report their operations in 1871, it would be unnecessary for me to do more than advert to it, were it not for the fact that this second report does not appear to have been generally distributed and is rarely seen. The following quotation will suffice to show the extent and severity of this visitation:

"Some idea of the loss caused by the depredations of this insect, in this and neighboring States, may be realized when we learn that over a belt of territory 100 miles wide, commencing in the western part of Indiana, and extending more than 400 miles west, embracing an area of more than 40,000 square miles, the great staple of spring wheat was reduced to not more than a quarter of an average crop, and in many places wholly destroyed; and that over the same territory barley was

less than half a crop, and oats not more than three-quarters of their usual amount.

"The center of this belt appears to have been a little north of the center of the State, being about on a line with the junction of Iowa and Missouri, and taking in a corresponding part of Southern Iowa and Nebraska and of Northern Missouri and Kansas. South of this belt winter wheat takes the place of spring wheat and barley, and the chinch-bugs, though present in considerable numbers, ceased to commit any very serious damage. North of this belt, also, notwithstanding that spring wheat constitutes a leading crop, the bugs became gradually less numerous, and a tolerable crop of this grain was harvested. And yet all through Northern Illinois and the southern part of Wisconsin, these insects were numerous enough to damage the crop to some extent, and to excite the most serious apprehensions for the succeeding year.

"In order to obtain as correct an idea as possible of the amount of loss sustained by the agriculturist from the depredations of this insect the past year (1871), both in this and the Northwestern States, I have made the following calculations, based upon the statistics of the Department of Agriculture, with a reasonable estimate of the proportional damage caused by this insect to those crops upon which they depredate. All such calculations must necessarily be only approximately correct, and very loose and extravagant conjectures have sometimes been indulged in upon the loss caused by chinch-bugs in former seasons of their prevalence. It has been my intention to keep within reasonable bounds, and, by giving the figures in the case, I give others the opportunity to review my estimates.

"Taking the returns of the Department of Agriculture, for the years 1869 and 1870, for our guide, we may assume the present annual yield of wheat in the State of Illinois to be 30,000,000 of bushels, of oats 40,000,000, and of barley 3,000,000.

"The area seriously ravaged by these insects comprised, as we have above stated, about the middle third of the State. This section would bear its full proportional third of the wheat and oats, and at least one-half of the barley raised in the whole State. This would give as the product of that part of the State ravaged by chinch-bugs 10,000,000 bushels of wheat, upwards of 13,300,000 bushels of oats, and 1,000,000 bushels of barley. The proportion of these crops destroyed by chinch-bugs we have put at three-quarters of the wheat, one-half of the barley, and one-quarter of the oats. This will give as the amounts actually destroyed by these insects, 7,500,000 bushels of wheat, 500,000 bushels of barley, and in round numbers, 3,300,000 bushels of oats.

"If we make a cash estimate of this loss, by putting the price of wheat at \$1 a bushel, barley at 50 cents, and oats at 25 cents, we shall have an aggregate loss of upwards of \$8,500,000 in the central third of the State of Illinois.

"In this estimate we have made no account of the injury done to corn throughout the State, nor of the damage to small grains north of the central belt. Here the calculation becomes much more indefinite, but I believe it will be generally admitted to be a low estimate if we add, for this purpose, one-quarter part to the above aggregate of loss. This will make the total loss caused by chinch-bugs in the State of Illinois, in the year 1871, upwards of \$10,500,000. If we assume an equal amount of loss for the two States of Iowa and Missouri combined, and another equal amount for the four States of Indiana, Kansas, Nebraska, and Wisconsin, we shall have a total loss in one year, in the Northwestern States, of upwards of \$30,000,000 from this one species of insect."

The loss in 1874 was probably equal to that in 1864; and I think actually greater.

Professor Riley made careful estimate by counties of the loss in Missouri, which he found to aggregate the large sum of \$19,000,000. I made careful estimates of loss on corn alone in Illinois by this insect in 1874. These estimates were based on different data, so as to form checks the one upon the other, and the loss by drought was eliminated. The result showed a loss of about \$20,000,000 on this single cereal. The entire loss to the State that year by the operations of this pernicious insect were not less than \$30,000,000, or \$11.50 to each inhabitant.

If the loss in the two States, Missouri and Illinois, amounted to nearly \$50,000,000, it is not probable that the entire loss to the nation by this diminutive insect in 1874 fell any short of \$100,000,000.

As the species appears to have a maximum of development about every five years, the foregoing estimates render it probable that the annual loss to the nation by its operations averages \$20,000,000.

Is it possible to prevent this great drain upon the agricultural industry of our country or to materially lessen it? To obtain, if possible, an affirmative answer to this inquiry is the object of the Commission. That this loss to a large extent may be prevented is confidently believed; but to do this, it is first necessary to have the farmers of our country fully informed in reference to all that is known respecting the characteristics, life-history, and habits of the species; also in reference to the various remedial measures which have been tried or suggested, and what the result has been so far as they have been tested. It is also necessary to inform them fully in reference to what co-operation is necessary, the plans that have been tried, and the result.

Our object, therefore, in presenting this bulletin is to give a brief *resumé* of what has been ascertained up to the present time in regard to the history and habits of the chinch-bug, and what remedies have heretofore been tried or suggested. This is done with the hope that the farmers throughout our country will aid us in this work, which the liberality of our national Congress has ordered for the benefit of the agricultural interests of the nation, and by testing practically the remedies suggested or others that may suggest themselves, and, informing us of the results, enable us to determine the best possible means of counteracting this pest.

The early history of its operations in our country is briefly given by Dr. Fitch in his second report on the Noxious Insects of New York, from which we extract the following:

"It was just at the close of our Revolutionary struggle, or about the year 1783, that this bug was first noticed as a depredator upon wheat, in the interior of North Carolina. It was at first supposed to be identical with the Hessian fly, which at this time was making such destruction in wheat crops on Long Island and in New Jersey. Two years before this, the British Army, accompanied by a detachment of its German auxiliaries, had marched through North Carolina, and the battle

of Guilford was fought. Mr. J. W. Jeffreys states (Albany Cultivator, first series, vol. vi, p. 201) that an aged and highly respectable citizen of Orange County, North Carolina, informed him that it was 'immediately after this event that the Hessian fly or Hessian bug destroyed their crops of wheat; and they believed and do believe to this day (1839) that those soldiers left the flies or bugs as they passed through the country.' The insects continued to increase and spread through the Carolinas and Virginia for several years. In 1785 the fields in North Carolina were so overrun with them as to threaten a total destruction of the grain (Webster on Pestilence, vol. i, p. 279). And at length the crops were so destroyed in some districts that they were obliged to wholly abandon the sowing of wheat. It was four or five years that they continued so numerous at this time.

"The only particular account which was published of the insect and its habits at this period, of which we have any knowledge, appeared in London, in Young's Annals of Agriculture, vol. xi, p. 471. It is from this notice of it, Kirby and Spence state, that they derive the information given in their Introduction to Entomology (p. 127, American edition), which is as follows: 'America suffers also in its wheat and maize from the attack of an insect, which, for what reason I know not, is called the chintz-bug fly. It appears to be apterous, and is said in scent and color to resemble the bed-bug. They travel in immense columns from field to field, like locusts, destroying everything as they proceed; but their injuries are confined to the States south of the fortieth degree of north latitude. From this account the depredator here noticed should belong to the tribe *Geocorisæ* Latreille; but it seems very difficult to conceive how an insect that lives by suction, and has no mandibles, could destroy these plants so totally.'

"About the year 1809, we are informed by Mr. Jeffreys that the chinch-bug again became so destructive in North Carolina that in Orange County the farmers had to abandon the sowing of wheat for two years, and according to his statement the insects were subdued thereby. At various other times, of which we have no record, it has undoubtedly been abundant in that and the adjacent States, that section of country appearing to be its headquarters.

"In 1839, we have accounts of its having again become excessively numerous and destructive in Virginia and the Carolinas.

"The bug had now become so numerous in Carolina and Virginia that, with its continued increase in 1840, the total destruction of their crops appeared inevitable. The prospect was so alarming that Sidney Weller, of Brinkleyville, Halifax County, North Carolina, and others in his neighborhood, united in the spring of 1840 in pledging a handsome sum as a prize for some feasible method to arrest the career of this depredator. But at this juncture Providence interfered to accomplish what no human agency could have effected. Instead of being dry, like the two or three preceding years, the summer of 1840 proved to be of an opposite character, and the ravages of this insect were at once suppressed.

"It was about this period that the chinch-bug began to be noticed along the Upper Mississippi and through the northern parts of Illinois. It made its appearance there simultaneously with the establishment of the Mormons at Nauvoo (1840-1844), and many ignorant people firmly believed they were introduced there by these strange religionists, and 'Mormon lice' became the name by which they were currently designated through that district."

The history of its operations in Illinois from the time it was first observed, in 1840, up to 1877 is given by the writer quite fully in his

Second Report on the Noxious and Beneficial Insects of Illinois. This may be briefly summarized as follows:

The first notice of it in the State was in 1840, when it appeared in the northwestern portion, near the Mississippi, and in Tazewell County. There is also reason to believe it appeared this or the following year in Saint Clair County. In 1844 it was somewhat injurious in Sangamon and some other sections. In 1845 it did extensive damage in Knox, Tazewell, Will, and some other counties. In 1846 it was observed in Cass County. In 1847 it appeared in Lyons County, Iowa. In 1848 it was observed in Lake County, Indiana, but there is no mention of it that I can find in Illinois in 1847, 1848, or 1849. But it is more than probable it began to develop in 1849, as it appeared in destructive numbers in 1850 over a large portion of Northern Illinois. Formidable numbers appeared in Illinois and the adjacent portions of Indiana and Wisconsin in 1854 and 1855, especially the latter year. This, according to Mr. Williams, of Geneva, Wis., was its first appearance in that State, coming from the south. In 1855 it did considerable injury in Mercer and De Kalb Counties and some portions of Southern Illinois. In 1857 and 1858 it was observed in limited sections of the State. In 1861 and 1862 it was reported by Dr. Shimer as doing considerable injury in the northwestern portion of the State. In 1864 the crops in Iowa and adjoining sections of Illinois suffered largely from its attacks, as did also other portions of the Northwest. It again made its appearance in Illinois in 1865, but the season being wet the insects were destroyed.

In 1868 and 1869 it appeared in limited numbers in the southern portion of the State, but its development was cut short by the wet weather. The year 1871 was marked by its appearance in vast numbers over the Northwestern States; and, as heretofore stated, 1874 was also another noted chinch-bug year.

The following brief notice of its history in other sections is given here, but this we expect to make more complete in our second report.

From Professor Riley's seventh report as State Entomologist of Missouri, we learn that it appeared in that State as early as 1836; that it was more or less injurious in certain sections in 1854, 1855, 1856, 1857, and 1859; that in 1866 it was quite destructive, as also in 1870-'71; but 1874 was the year in which it was most injurious in this State.

From a communication received from Mr. J. H. Wissler, of Lockville, N. C., we learn this insect was very destructive in that State about 1837, a date not mentioned by Dr. Fitch. The same writer also states that "it was very troublesome about twenty years ago (1859)," at which time we learn by a letter from Mr. E. A. McWhorter, of Camden County, Georgia, that it injured the rice crop in that county, the only certain notice we have of its appearance in that State.

Mr. W. J. Ross, of Stanley County, North Carolina, writes us that "these insects were abundant and did much damage in that county in 1837 and 1845."

It appears from Dr. Fitch's second report that they were so numerous in Virginia and North Carolina in 1856, as to spread a general alarm from the mountains to the seaboard.

NAMES AND DESCRIPTION.

The chinch-bug is a small insect less than one-fourth of an inch long, its length usually not exceeding three-twentieths of an inch; its width something less than one-half its length; rounded on the underside and flat above; of a coal-black color, with white wings which have a triangular, black dot on their outer margins. It belongs to the order *HEMIPTERA* and sub-order *Heteroptera*, to which group also belong the common bed-bug, squash-bug, and other similar true bugs. This species, like all the rest belonging to the order, has the mouth prolonged into a slender, horny, jointed beak, usually turned under the breast when not in use. With this instrument, and the slender needle-like setæ inclosed within it, they puncture the bark, leaves, and stems of plants, and suck out their juices. It is in this way the chinch-bug obtains its food. As it has no means of gnawing plants, and is so diminutive in size, it would appear to be incapable of inflicting any very serious injury on vegetation; but, as heretofore stated, what it lacks in individual capacity for inflicting injury is made up by the immense numbers which are occasionally developed. A myriad of tiny pumps incessantly drawing away the juices of a plant must in a short time cause it to decay and die.

Although, as we have seen, the insect was known long before 1831, yet it was not until that year that it was scientifically described by Mr. Say, who "took a single specimen on the Eastern Shore of Virginia." This description, under the name *Lygaeus leucopterus*, was given in a small pamphlet on the *Heteropterous Hemiptera* of North America, published by Mr. Say at New Harmony, Ind., December, 1831, and is as follows:

"*Lygaeus leucopterus*.—Blackish, hemelytra white with a black spot. Inhabits Virginia. Body long, blackish, with numerous hairs; antennæ, rather short, hairs: second joint yellowish, longer than the third, ultimate joint longer than the second, thickest; thorax tinged with cinerous before, with the basal edge piceous; hemelytra (elytra) white, with a blackish oval spot on the lateral middle; rostrum and feet honey-yellow; thighs a little dilated. Length less than three-twentieths of an inch."



FIG. 1.
Chinch-bug. The line below shows the natural length.

Nineteen years afterwards Dr. Le Baron, not aware that the species had previously been described, named it *Rhyparochromus devastator*, and gave the following description in the *Prairie Farmer* of September, 1850:

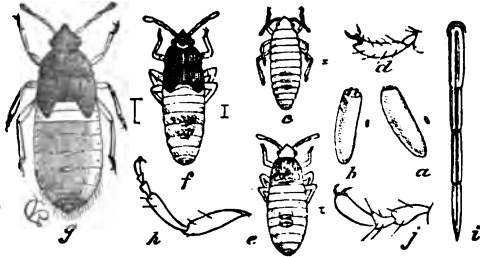
"Length $1\frac{3}{4}$ lines or three-twentieths of an inch. Body black, clothed with a very fine grayish down not distinctly visible to the naked eye; basal joint of the antennæ honey-yellow, second joint the same, tipped with black, third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their inser-

tion, and have near the middle two short, irregular black lines, and a conspicuous black marginal spot; legs dark honey-yellow, terminal joint of the feet and the claws black."

Numerous descriptions of the young or larva have been given, but that by Professor Riley in his seventh report is perhaps the most complete, and as it leaves nothing to add, being taken from fresh specimens and including the egg, I copy it here, together with his excellent figure of the preparatory stages:

"*Egg*.—Average length .03 inch, elongate-oval, the diameter scarcely one-fifth the length. The top squarely docked and surmounted with four small, rounded tubercles near the center. Color, when newly laid, pale or whitish, and translucent, acquiring with age the amber color, and finally showing the red parts of the embryo, and especially the eyes toward the tubercled end. The size increases somewhat after deposition, and will sometimes reach near .04 inch in length.

FIG. 2.



Chinch-bug, Larva, Pupa, and Egg. *a* and *b*, eggs; *c*, young larva; *d*, tarsus of same; *e*, larva after first molt; *f*, larva after second molt; *g*, pupa; *h*, leg; *i*, the beak or tubular mouth; *j*, tarsus of mature bug.

"*Larval stages*.—The newly hatched larva (Fig. 2, *c*) is pale yellow, with simply an orange stain on the middle of the three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi have but two joints (Fig. 2, *d*) and the head is relatively broader and more rounded, while the joints of the body are subequal, the prothoracic joint being but slightly longer than any of the rest. The red color soon prevades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. After the first moult (Fig. 2, *e*) the red is quite bright vermillion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint [first behind the head] is relatively longer, and the metathoracic joint [third behind the head] shorter. The head and prothorax are dusky and coriaceous and two broad marks on the mesothorax [second joint behind the head], two smaller ones on the metathorax, two on the fourth and fifth abdominal sutures, and one at the tip of the abdomen are generally visible, but sometimes obsolete; the third and fourth joints of the antennæ are dusky, but the legs are still pale. After the second moult [Fig. 2, *f*] the head and thorax are quite dusky and the abdomen duller red, but the pale transverse band is still distinct; the wing-pads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joints, and ventrally a distinct circular dusky spot covering the last three joints.

FIG. 3.



Short-winged Chinch-bug.

"*Pupa*.—[Fig. 2, *g*]. In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints, which are now more dingy, while the general color of the abdomen is

dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three-jointed tarsus is foreshadowed, and the dark horny spots at the tip of the abdomen, both above and below, are larger."

The characters of the perfect insect are so fully given in the descriptions by Say and Dr. Le Baron, already quoted, that it is unnecessary for me to repeat them here. I may add that the antennæ, which are not described, are a little less than half the length of the body, composed of four joints, the last being the largest. Dr. Fitch has also pointed out the following varieties:

"*a, immarginatus*.—Basal margin of the thorax not edged with yellowish. Common.

"*b, dimidiatus*.—Basal half of the thorax deep velvety black, anterior half grayish. Common.

"*c, fulvivenosus*.—The stripes on the wing-covers yellow instead of black.

"*d, albivenosus*.—Wing-covers white, without any black marks except the marginal spot. A male.

"*e, apterus*.—Under or true wings wanting, wing-covers much shorter than the abdomen.

"*f, basalis*.—Basal joint of the antennæ dusky and darker than the second.

"*g, nigricornis*.—First two joints of the antennæ blackish.

"*h, femoratus*.—Legs pale livid yellow, the thighs tawny red. Common.

"*i, rufipedes*.—Legs dark tawny-red or reddish-brown."

Professor Riley adds another, *melanosus*, "in which the usual white of the wings is quite dusky and contains additional black marks at the base and toward the tips, and in which all the members and the body, except the rufous hind end of the thorax, are jet black."

It is but an act of justice to state that as early as 1845 (Prairie Farmer for October, 1845) Mr. J. Hadley gave the first brief description of the larval state; although brief and making no pretensions to scientific accuracy, yet the larval and pupal states are clearly indicated.

There is also occasionally seen in the northern sections a short-winged form of the perfect insect, such as is shown at Fig. 3.

The common name Chinch-bug is from the Spanish *chinche*, signifying bug. The name *chintz* and *chink bug* were formally occasionally used. As special notice was first called to them in Illinois, in the section and about the time the Mormons came to Nauvoo, they were named "Mormon lice."

NUMBER OF BROODS AND HIBERNATION.

It was known soon after the insect became troublesome that there were more broods than one, some, as Mr. Hadley, supposing there were "five or six generations." It is a quite common opinion, and is held by many to the present day, that there are three broods. This belief arises very naturally from the fact that those which hibernate appear in the spring to deposit eggs; the perfect insects from these are counted as a

second brood, the fall brood being the third, according to this method of counting; but, as will be seen by careful observation, those which appear in the spring are the same ones seen late in the fall. Dr. Shimer observed in 1864 and 1865 that this species is two-brooded, but no account of his observations were published until 1867. In the mean time, Professor Riley published the fact in 1866 that they are but two-brooded in the northern part of Illinois. Subsequent observations have shown this to be the rule in the other parts of the State and throughout the Northwest. There is some evidence of an occasional third brood in the extreme southern part of the State and in Kentucky, but not sufficient to justify me in asserting it as a fact or to satisfy me of its correctness.

Insects may pass the winter as eggs, which is a very common method; as larvæ or young, which is rather unusual; as pupæ, which is a very common method in those orders where the pupa state is one of complete quiescence; and, lastly, they may pass the winter as perfect insects.

The last method is the one adopted by the Chinch-bug. When cold weather comes on, those of the fall brood leave the now dry and hardened corn-stalks and seek secure places in which to remain during the winter. Occasionally they take flight at this time, but usually they seek the most secure places which can be found in and immediately around the field. Any rubbish left in the field, if of a nature to meet their wants, is eagerly sought; corn-shocks, straw-piles, stumps, logs, and fence-rows are used as hiding-places; they even hide beneath the clods when no better places can be found. But many move into the forest, grove, or woodland, if either happens to be near at hand. I have found also that the line of bushes along a little branch traversing the field is a favorite resort. Sheds, barns, rail-fences, and stacks often furnish them with winter quarters.

During the winter they remain in a torpid or semi-torpid state, but are easily warmed into life and activity. As the cold weather becomes more and more severe they press deeper and deeper, if possible, into the inner recesses of their hiding-places. They prefer dry quarters if readily obtained.

Whether the males survive in equal numbers with the females is a point not ascertained, so far as I am aware, but I am of the opinion that the females are the more numerous.

Their time of coming forth in the spring depends upon the latitude and season. In a few instances in unusually early springs they have been seen as early as the middle or latter part of March in the southern end of this State; while, on the other hand, in the northern part of the State in a late spring they have delayed their appearance until late in May, and probably even until the first of June. Usually they come out during the month of April in the southern and central part of the State. But it must be admitted that there is but little testimony on this point, as but very few of our farmers pay any attention to insects except when

they become injurious or appear in immense masses. The chinch-bug, when flying, would scarcely be distinguished by the unpracticed eye from a gnat. On this account our correspondence, and the printed and manuscript notes we have examined, make far more frequent mention of the first appearance of the young than they do of the spring appearance of the hibernating brood.

In order to show the various hiding-places they select in which to hibernate, I quote the following notes from correspondents as found in my second report :

“When winter set in they went into winter quarters under corn-shocks, clods, rails, &c.”

“I have never known them to winter in timothy or any tame hay ; but if you want to raise an extra crop of bugs, leave a few bottoms of prairie-hay stacks and piles of corn-fodder and straw until June, and, my word for it, you will have them.”

“Their winter quarters are old rail fences, corn-stalks, house-roofs, logs, leaves, &c.”

In addition to these places, we may add that in timbered sections they frequently go to the woods and seek shelter under the leaves and in the crevices of the bark of trees, under loose bark, and even hide under stones. I have found them quite abundant in old stumps and old logs, and around fields which have been in corn during the summer previous. When no other hiding-place can be found they will seek shelter from the cold under clods of earth.

As the cold increases they will penetrate farther and farther into their recesses. They prefer comparatively dry situations, as moisture appears to be inimical to them, though in this stage of their existence it does not appear to be necessarily destructive of life, as the following statement in my second report, given by a correspondent on whose veracity and intelligence I can rely, will show :

“They have been taken from ice, by thawing it, and when slightly warmed would manifest signs of life, crawling about as in spring. They thus appear to be able to endure cold or heat.”

I have often taken them in winter inclosed in a covering of frost and to all appearances frozen stiff, yet when placed in a warm atmosphere for a time they would survive.” The following statement by Dr. Henry Shimer, of Mount Carroll, Ill., in reference to their winter life, will be interesting in this connection :

“After the early autumn frosts they left their feeding-grounds, on foot, in search of winter quarters ; none could be seen on the wing as at harvest time. For a winter retreat they resorted to any convenient shelter they might chance to find, as long grass, weeds, boards, pieces of wood, rails, fallen tree leaves, &c.

“In January, 1865, I next examined their condition ; those that I found in the sheaths of the corn-leaves, above the snow, and had been thus exposed during the previous severe weather—when for several successive days the thermometer was 15° to 20° below zero—were invariably found dead, without exception, and those beneath the snow were alive. This observation was made in the common farm corn-fields, as

they might be found anywhere all over the wide country, for in autumn the chinch-bugs remained in great numbers in the corn-husks and under the sheaths of the blades, as well as in other winter retreats. Upon various occasions, as the winter advanced, I brought in corn-husks filled with ice, inclosing the chinch-bugs in the crystallized element; when the ice was thawed they were able to run, apparently unaffected by that degree of cold. It is therefore proved that these insects possess vitality sufficient to withstand the effect of a temperature below the freezing-point, and perhaps below zero, as must have been their condition in these ice-bound husks; but when in the open air, exposed to the sweeping prairie winds, 15 or 20 degrees below zero, for a long time, they succumb to the cold.

"*March 7, 1865.*—The snow having cleared off from the ground, I examined the condition of a host of these chinch-bugs that had chosen for their winter covering cord-wood sticks lying on the ground, entirely surrounded by frost and ice; of these 20 per cent. were living; those that were more fortunate in their selection of winter quarters fared much better. From a single handful of leaves picked up at one grasp from beneath an apple tree, I obtained 355 living and 312 dead chinch-bugs; and of their lady-bird enemies that had entered the same winter quarter with them, 50 were living and 10 dead. Of these chinch-bugs I placed a number in comfortable quarters in the house in a small paste-board box—not in a stove room—together with some coleopterous insects casually gathered among the chinch-bugs; after one month I found the latter all dead and the former living.

"The entire month of March was rain, snow, thawing, freezing, alternately, seeming to be very uncomfortable for any living creature to remain out of doors with so poor a shelter and on top of the ground.

"April 1-6, I again made repeated examinations of these chinch-bugs in their winter quarters, and found about the same proportion of them living as noted on the 7th of March. At this time they wandered away on foot from their winter quarters."

THE FIRST BROOD.

Immediately after they come out of their winter quarters in the spring, which varies, according to latitude and the season, from the latter part of March to the middle of May, they pair. Dr. Shimer states in the article from which we have just quoted that he observed them at this time on the wing, which he appears to think is their usual method during the time of their amours, but observations made by myself and others do not confirm this opinion; on the contrary, they show it to be unusual.

After pairing, the females commence laying their eggs, and, unfortunately for the farmer, nature appears to have made a special provision for them to adapt them to the vicissitudes of season, and even in reference to the method of oviposition. If compelled to deposit all their eggs at one time, an entire brood might be destroyed by a single drenching rain; but the female proceeds leisurely with her work, day by day depositing a few, those in her ovaries developing as necessity demands, the process being carried on for two, or even three weeks. According to the observations of Dr. Shimer, the usual time occupied in this work is about twenty days, and the number deposited about 500.

As a general rule, the eggs deposited at this time are placed just below the surface of the soil on the roots, or on the stem near the surface. The moisture of the soil at the time probably has something to do with the position chosen, the higher being selected when it is damp, and the lower when it is dry; the condition as to compactness or hardness doubtless has also something to do with the position selected. Dr. Shimer remarks that he "found the chinch-bug eggs more abundant mostly on the roots and stalks beneath the ground, sometimes in loose clusters of a dozen or more. They were on the roots, where they crossed the numerous cracks in the ground; less frequently on the stem, at the surface of the ground." Sometimes, as before intimated, this is reversed, and they are more abundant on the stem near, or just beneath, the surface than on the roots.

Numerous observations show that the eggs are more liable to be affected by climatic influences than the perfect insects, and are sooner destroyed by heavy rains. The moisture has the effect of dissolving the substance by which they are attached to the stalks, and the water carries them down into the moist soil and destroys their vitality. The following statement by Professor Ross, in the communication before alluded to, is quite interesting in this connection. His letter is dated June 4, 1875:

"Within the last week we have had two heavy showers of rain. Before either of them fell I examined very carefully the eggs deposited about twelve or fifteen days ago. They were very abundant on nearly every stalk of wheat, always deposited within one or two inches of the ground, in the sheath close to the stalk. There were probably an average of fifty eggs on the stalk. This evening, four days after the first examination, with a good glass, magnifying twenty-five diameters, at hand, I examined the same field of wheat at the same place as my first examination. I found but few old bugs; some of the eggs had hatched out, but by far the greater number of eggs were washed down from their places, distorted in shape, sunken into the soil, and many decomposed; probably not more than one in ten of the first I saw had developed into a bug. I could easily tell the eggs that were destroyed. I examined many stalks on which I found no eggs. Abundant evidence is at hand in proof of their destruction in the egg state by rain."

The egg is at first of a pale dull whitish or testaceous color, but at length assumes a reddish color, from the changes transpiring within; the embryo can be seen as a red speck in the center through the transparent shell. When first hatched the young bug is red with a white stripe across it; afterwards it turns of a brownish or grayish-brown color. Soon after it is hatched it inserts its tiny beak into the plant on which it is situated and commences pumping out the juices on which the vigor and life of the plant depend. As their growth is rapid their molts are frequent; before reaching the perfect or winged state it passes through four of these changes, varying in color and markings after each. According to Mr. Riley's observation, "It is bright red, with a pale band across the middle of the body after the first; some-

what darker with the merest rudiments of wing-pads after the second ; and quite brown with distinct wing-pads, but with the pale transverse band still visible after the third." The entire process requires from five to seven weeks ; according to Dr. Shimer's observations, from the time the egg is deposited until the imago appears is usually from fifty-seven to sixty days.

It is but a short time after they reach the perfect state—a few days only—before they pair, and the females deposit their eggs. The insects produced from these constitute the "fall" or "second brood," and pass through the same changes as those of the first brood. The perfect insects of this brood, as before stated, live through the winter. In the southern part of this State, at least, it is not an uncommon thing to find the pupæ wintering over ; whether those caught in this condition acquire complete wings in the spring is a question I am as yet unable to answer. I have observed, as I think, a similar fact in reference to the corn *Aphis* (*Aphis maidis*) ; but in neither case have I had an opportunity of observing the final result.

MIGRATIONS.

Before the females of this brood deposit their eggs they leave their original quarters and migrate in search of a more abundant supply of food. When this movement takes place it appears to be a very general one, and not, as sometimes supposed, solely for the purpose of enjoying the season of their amours or for depositing eggs, though these may be and doubtless are often in part the cause of this movement. About this time the wheat becomes dry and hard, and no longer furnishes a supply of food ; hence, they are necessarily forced to migrate or perish. Occasionally they take to flight, and this appears to be more common some years than others, depending to a great extent upon the state of the weather, and perhaps to a certain degree upon being the time of their amours, as suggested by Dr. Shimer. But the far more usual and almost universal method is by marching along the surface of the ground. There appears to be no uniformity in the direction taken ; in fact, they sometimes scatter and go in different directions from the same field, but as a general thing the masses take one direction, which is towards the nearest field of corn, oats, or some other cereal or grass that is still in a succulent state. In those sections where corn is the chief or second crop it is generally attacked. As the number of stalks to a given area is much less than in the wheat-field the forces are concentrated, and each stalk of corn receives the bugs of perhaps a hundred wheat-stalks. When the insects are very numerous the effect is soon visible.

In these migrations the insects are by no means all matured ; often the majority have not advanced beyond the pupa state, but the want of nourishment forces them to "go west" or in some other direction in search of food. In all such movements mature and immature individuals

will be observed. In some instances the numbers are so great that not only is the surface of the ground literally covered, but they are piled on each other. If disposed to fly, which is not often the case, it sometimes becomes necessary to protect the nostrils of the horses at work in the fields. Those who have never witnessed a movement of this kind have a very faint idea of the immense numbers of individuals there are, and the vast army of insects a single field of wheat has been feeding. Simply a matter of curiosity I have made a calculation in order to ascertain the number of individuals on a given area. Suppose it to be the side of a field 40 rods long from which they were issuing and that they covered the ground completely, but singly, for a width of one rod, this would give at least 175,000,000 individuals. If the corn-field attacked was 40 rods long, this would give about 17,000 individuals to each hill for a depth of fifty rows.

The following quotations will serve to illustrate this habit:

"When the dry straw of the wheat-fields no longer afforded them nourishment, they took up their line of march for the corn-fields, literally covering the ground in many places; sometimes gathering together into piles, and here casting their skins. This, being observed carelessly by farmers and others, leads them to declare that 'the chinch-bugs were destroying each other,' that 'they were dying,' &c.; the dry shells remaining behind being mistaken for the insect itself.

"I have seen the columns of these insects a full week on the march across the meadows and pasture-fields from the wheat to the corn-field, and have even seen them swim a small stream of water that crossed their line of march. In former years the few border rows of corn, together with the 'fox-tail grass' (*Setaria*), carelessly left among the corn in cultivating, usually satisfied them. This latter grass is usually attacked in preference to the corn.

"In 1864, whole corn-fields were overrun by them; the stalks, especially below the ears, blackly covered through the day, were bleeding and literally ran from their numerous punctures. At length when they had attained the perfect state during the warm part of bright sunny days, they took to their wings, and literally filled the atmosphere, not much unlike an April snow-storm. This interesting phenomenon induced many to believe that they were leaving the country; but it was for an entirely different purpose—that of choosing their mates—for they never fly except in the love season. After a few days they might be found paired in corn-fields and other proper breeding grounds, producing a new generation. At this time in the month of August, 1864, my attention was very favorably directed to a small field of tender, thickly-sown corn for fodder, where they congregated in immense numbers, and continued until the frosts of autumn had killed the corn that they did not consume, and developed their progeny in unnumbered millions. During the day they resorted to the stalks of corn to feed upon the juice, but they passed the night usually upon the ground."—(Dr. Shimer.)

Dr. Le Baron, in his first article published in the *Prarie Farmer* in September, 1850, writes as follows:

"Meanwhile the grain, being deprived of its necessary nutriment becomes wholly blasted or much shrunk, whilst the straw turns white prematurely and at length crinkles down beneath the lancets of this infinity of phlebotomists.

"When the wheat becomes too much dried up to afford them nutriment, they leave the wheat-field and may be seen at this time running upon the ground in all directions in search of appropriate food. Next to wheat they usually attack oats, then corn, and lastly timothy or herds grass; and if none of these are at hand, they will subsist upon some of the wild grasses. The Indian corn is so rapid and vigorous in its growth that it is not usually much injured; yet I have seen this season whole fields blackened with them, and large patches of corn blasted and prostrate, as if a fire had run over them.

"They migrate from one field to another by running over the surface of the earth. Nevertheless, when they are obliged to move to a distance the perfect or winged individuals readily take to flight, and they have been seen flying in dense swarms."

The following interesting account of their migrations, given by an Illinois farmer, was published in the Proceedings of the New York Farmers' Club, June, 1866:

"In passing by a field of barley where the chinch-bugs had been at work for a week, I found them moving in solid column across the road to a corn-field on the opposite side, in such numbers that I felt almost afraid to ride my horse among them. Some teams were at work mending the road at this spot, and the bugs covered men, horses, and scrapers, till they were forced to quit work for the day. The bugs took 10 acres of that corn clean to the ground before its hardening stalks checked their progress. Another lot of them came from a wheat field adjoining my farm into a piece of corn, stopping now and then for a bite, but not long. Then they crossed a meadow 30 rods into a 16-acre lot of sorghum and swept it like a fire, though the cane was then scarce in tassel. From wheat to sorghum was at least 60 rods. Their march was governed by no discoverable law, except that they were infernally hungry and went where there was most to eat. Helping a neighbor harvest in one of the few fortunate fields, early sown, we found them moving across his premises in such numbers that they bid fair to drive out the family. House, crib, stable, well-curb, trees, garden-fences—one creeping mass of stinking life. In the house as well as outside, like the lice of Egypt, they were everywhere; but in a single day they were gone."

Their migrations on foot seldom exceed 80 rods.

NATURAL AGENCIES WHICH ASSIST IN THEIR DESTRUCTION.

Many insects are subject to the attacks of enemies which appear to be adapted by nature to prey upon them. Unfortunately for our agriculturists this little pest seems to be followed by no such relentless enemies as those that pursue the army-worm, plant-lice, &c. Even the carnivorous species which wage such an incessant warfare against the rest of the insect tribes, appear to have little or no taste for such an unsavory morsel as the chinch-bug, and if we judge them by our own nasal organs we cannot blame them. Still there are a few that now and then prey upon them, but even these do not appear to follow up the work very vigorously; nor are they sufficiently numerous to make any material impression on the vast hordes of these insects that occasionally pervade our grain-fields.

The following statements copied from Mr. Riley's seventh report cover about all that is to be said in reference to them :

"As long ago as 1861, Mr. Walsh, in his Essays upon the Injurious Insects of Illinois, published facts which tended to show that four distinct species of ladybirds preyed upon the chinch-bug. The first of these four is the spotted ladybird (*Hippodamia maculata* De Geer, Fig. 4), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado potato-beetle and those of certain bark-lice.



Spotted Ladybird.

"In corroboration of the fact of its preying on the chinch-bug I may state that the Rev. Charles Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the trim ladybird (*Coccinella munda* Say, Fig. 5)

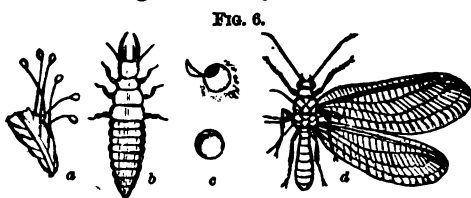


Trim Ladybird.

which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which, therefore, belong to very different groups and have very different habits.

"In the autumn of 1864, Dr. Shimer ascertained that the spotted ladybird, which has been sketched above, preys extensively upon the chinch-bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with chinch-bugs, he found, as he says, that this ladybird 'could be counted by hundreds upon every square yard of ground after shaking the corn; but the chinch-bugs were so numerous that these hosts of enemies made very little perceptible impression among them.'

"In the same autumn, Dr. Shimer made the additional discovery that in the very same field of fodder-corn the chinch-bugs were preyed upon by a very common species of lacewing fly, which he described in January, 1865, as the Illinois lacewing (*Chrysopa Illinoensis*). The description was republished, together with the substance of Dr. Shimer's observations, in the Prairie Farmer, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon, and imago. At this time Dr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens it is evident that the species is the same as that described long before by Dr. Fitch as the weeping lacewing (*Chrysopa*



Lacewing fly, larva, eggs, and cocoon.

plorabunda), Fig. 6. In 1868, I found the same species quite numerous in a wheat-field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the chinch-bugs, as they were found to do in North Illinois by Dr. Shimer. The lacewing flies all bear a striking resemblance to one another, both in size, shape, and color. Almost all of them, in the fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure.

"According to Dr. Shimer, the weeping lacewing fly was not quite as abundant as the spotted ladybird among the fodder-corn, but still there were so many of them that he thought that 'there was one or more of

them for every stalk of that thickly-sown corn.' 'Every stroke of the cutter,' he adds, 'would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight.' And he not only actually observed the larvæ preying very voraciously on the chinch-bugs in the field, but he reared great numbers of them to the mature fly by feeding them upon chinch-bugs. His account of the operations of the larvæ when in captivity is so interesting that I quote it in full:

"I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring chinch-bugs of all sizes, and subsequently introduced into the vial a number of chinch-bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way I saw it destroy, in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast it remained motionless for an hour or more, as if asleep. Never for a single moment during the feast did it pause in the work. When not in possession of a bug it was on a search for or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes when two or more bugs were approaching rapidly it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial so that it fell to the bottom and rolled over and over across the bottom, but holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the chinch-bugs would hasten to escape when pursued, as if in some degree conscious of danger.'

"The insidious flower-bug (*Anthrenus insidiosus* Say, Fig. 7), which is so often found preying on the leaf-inhabiting form of the grape *Phylloxera*, and which is not unfrequently mistaken for the chinch-bug, is quite commonly found in connection with this last, and in all probability preys upon it.

"The many-banded robber (*Harpactor cinctus* Fabr., Fig. 8) also preys upon the chinch-bug. It is quite frequently met with, and I have detected it in the act.

"The common quail of the Middle and Western States (*Ortyx Virginiana*), otherwise known as the partridge in the Northern States, has long since been known as a most efficient destroyer of chinch-bugs and the fact was some time ago published by myself in the *Prairie Farmer*, and by others in various agricultural journals and reports. We also have the corroborative testimony of Dr. Shimer, who is a good ornithologist. In the winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such

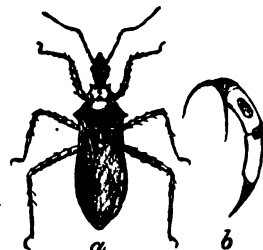
FIG. 7.



I

Insidious Flower-bug.

FIG. 8.



Many-banded robber.

situations as are frequented by the quail; and this bird should be protected from the gun of the sportsman in every State where the chinch-bug is known to run riot. It is gratifying to know that this fact has become sufficiently recognized to have gained for the bird legislative protection in Kansas. Prairie chickens are also reported as devouring it, but I do not know that any absolute proof has been given. Mr. J. W. Clarke, of Green Lake County, Wisconsin, also reports seeing the red-winged blackbird feeding on it.* Finally, Mr. B. W. Webster, of Austin, Cass County, and G. C. Brackett, Secretary of the Kansas State Horticultural Society, have both written me to the effect that ants destroy its eggs."

The most efficient of these aids appears to be the *Harpactor cinctus* or banded-bug. I received in 1878 notice from points in the Northwest that it was doing much service in destroying chinch-bugs, but it does not develop in sufficient numbers to make any serious impression on them in the years they are abundant.

To the list of enemies given in the foregoing extract we may add the frog, which, according to Professor Ross and others, consumes a large number. Professor Ross goes so far as to express the belief that the destruction of these animals by draining their natural haunts is one reason why the chinch-bug is enabled to multiply as it does in some seasons.

As before stated, they are perhaps more seriously affected by moisture than any other natural agency; and this fact has suggested to Dr. Fitch the idea of sprinkling, and to Mr. Riley irrigation, as remedies.

According to Dr. Shimer this species is occasionally subject to an epidemic disease that sweeps them away in immense numbers. The only known instance of its appearance was in 1865, as shown in the following quotation from his article in the Proceedings of the Philadelphia Academy of Natural Sciences heretofore mentioned:

"July 16.—A farmer four miles from here informed me that a black coleopterous insect was destroying the chinch-bugs on his farm very rapidly; and although I found his supposition to be an error, yet I found many dying on the low creek bottom-land from the effects of some disease, while they are yet in the larvæ state—a remarkable and rare phenomenon for insects thus in such a wholesale manner to be dying without attaining their maturity, and no insect enemy or other efficient cause to be observed capable of producing this important result.

"July 22.—On the low grounds the young chinch-bugs are all dead from the disease above alluded to, and the same disease is spreading rapidly on the hills and high prairies.

"The weather has been very wet since the first of July, and the barley above alluded to, which I plowed beneath the ground, did not die, but assumed a yellow, sickly appearance; in its shady, compressed, unnatural position, the ends of the heads project from beneath the furrows. The chinch-bugs also remained alive for a time, but feeding on the sickly grain and shaded from the sunlight, what little we had, were attacked by disease in the same manner and about the same time as those on the low creek bottom-lands, meeting very rapidly the same fate, so that very few of them ever found their way to the neighboring corn.

"July 28.—Great numbers in all stages of their development are dying of the prevailing disease.

* *Prairie Farmer*, April 9, 1870.

August 8.—The majority of the chinch-bugs yet alive are in the imago state, but they are being rapidly destroyed by the prevailing epidemic disease, more fatal to them than the plague or Asiatic cholera ever was to man, more fatal than any recorded disease among men or animals since time began. Scarcely one in a thousand of the vast hosts of young bugs observed at the middle of June yet remain alive, but plenty of dead ones may be seen everywhere lying on the ground, covered with the common mold of decomposing animal matter, and nothing else, even when examined by the microscope. Even of those that migrated to corn-fields a few weeks ago, in such numbers as to cover the lower half of the corn-stalks, very few are to be found remaining alive; but the ground around the base of the corn-hills is almost literally covered with their moldering, decomposing dead bodies. This is a matter so common as to be observed and often spoken of by farmers. They are dead everywhere, not lying on the ground alone, but sticking to the blades and stalks of corn in great numbers, in all stages of their development, larva, pupa, and imago.

August 22.—It is almost impossible to find even a few cabinet specimens of chinch-bugs alive, so that I am quite sorry that I did not secure a large supply of specimens while they were so numerous, in former years; for it really appears quite probable that even cabinet specimens will be hard to secure, whereby to remember the fallen race of the unnumbered millions of former years.

September 13.—It is generally believed among entomologists that insect enemies are the most efficient means in nature for exterminating noxious insects; but in this remarkable fact in the history of insects the great epidemic of 1865 (there can be no doubt about this being an epidemic disease, because the insects died without attaining their maturity) we find a greater enemy, the greatest insect enemy ever recorded, a dreadful plague, that in a few days almost utterly annihilated a race of beings living in the northern part of the valley of the Mississippi, outnumbering all the human beings that have ever lived on this planet since the morning of creation.

"This disease among the chinch-bugs was associated with the long-continued wet, cloudy, cool weather that prevailed during a greater portion of the period of their development, and doubtless was in a measure produced by deficient light, heat, and electricity, combined with excessive humidity of the atmosphere, whereby an imperfect physical (bug) organization was developed. The disease was at its maximum during the moist warm weather that followed the cold rains of June and the first part of July. The young chinch-bug spent a great portion of its time on or near the ground, where its body was colder than the atmosphere; hence, upon philosophical principles, there must have been an excessive precipitation of watery vapor in the bronchial tubes. These are the facts in the case, but in the midst of the great obscurity that envelops epidemic diseases among men, it would be only idle speculation to attempt to define the cause more definitely than the physiological laws already observed seemed to indicate. At all events it will require many years of warm, dry summers, and accompanying winters of plenty of snow for protection, to reinstate the lost innumerable armies of this insect.

"During the summer of 1866 the chinch-bugs were very scarce in all the early spring, and up to near the harvest I was not able, with the most diligent search, to find one. At harvest I did succeed in finding a few in some localities.

"This epidemic disease was not confined to the chinch-bug alone. Dur-

ing the summer of 1865, I saw the larvæ of the common striped cucumber-bug (*Diabrotica vittata*) on the stems of melon and cucumber vines, above ground, a very unusual place for them. Always before this I have found them on the root, beneath the surface of the ground. This unusual position was evidently to escape the effect of some unnatural conditions. During the latter part of the summer of 1865, the imagoes were very much less numerous than common.

"The apple-worm (the larva of *Carpocapsa (Tinea) pomonella* L.) was very numerous in 1863-'64, affecting almost every app.e. In 1865-'66, they were very much less numerous. From observation I conclude that the disease was produced by the same cause that swept away the chinch-bugs.

"The potato-worm (*Sphinx quinque-maculatus*) was very numerous in 1864, doing much damage to tomatoes, &c. The pupæ were extremely abundant in the soil in the spring of 1865, but in autumn no observed larvæ had survived.

"The *Locustidæ* (grasshoppers) were also severely afflicted; the numerous dead, of all states, were easily seen everywhere, clasping the grass, weeds, &c., in the embrace of death. I might add much more of my observations on these insects, and greatly extend the list of afflicted species, but my object, to prove that epidemic diseases are *incomparably* the most important agents in all nature in destroying noxious insects, has been sufficiently illustrated. Neither is this a mere isolation, for I have observed diseases among various insects for the past twenty-five years."

Although the plague among the bugs in this instance appears to have been somewhat extraordinary, yet it is in accordance with facts ascertained in reference to other insects, and as Dr. Shimer is both a competent and reliable authority we accept his statement as correct, and believe with him that it was owing as the originating cause to the damp season. But we are inclined to believe that the moisture gave rise to a minute fungus as the direct cause of the death of the chinch-bugs.

I recollect very distinctly of a similar wholesale destruction of house-flies in Southwestern Virginia and East Tennessee in 1849, by an epidemic. So rapidly was the disease propagated and so great the destruction among the flies, which were unusually abundant, that the utmost caution in cooking and in drinking water was necessary. Every moist spot was covered with the dead and dying. This I am satisfied was caused by a fungus.

I observed a somewhat similar epidemic prevailing among the grasshoppers in Western Minnesota, Dakota, and Northern Iowa in 1872. All over the plains the dead were seen clasping the stems of grass and weeds, and before I was aware of this fact more than once I approached cautiously to capture a desired specimen, only to find it dead and rigid. In 1877 the rainy season evidently caused an immense destruction of the larvæ of *C. spretus*.

ARTIFICIAL REMEDIES.

As Dr. Le Baron in his second report as State entomologist of Illinois, which is now out of print, discusses somewhat thoroughly the subject of

remedies, I will quote in full his remarks before mentioning the remedies proposed by myself and others.

"The plan of sowing grain so early in the spring as to get in advance of their depredations.

"The well known fact that winter-wheat generally matures before the young brood of chinch-bugs makes its appearance, and thus escapes their ravages, naturally suggested the idea that the same end might be accomplished with respect to spring-wheat, if the seed could be got into the ground very early in the spring. However plausible this supposition may appear, the experiences of the past season would seem to show that any reliance based upon it must prove, in a great measure, fallacious. Notwithstanding that the last spring was dry and favorable for the early sowing of grain, and notwithstanding that it is universally understood by farmers that the earlier wheat can be sown the better for the crop, and therefore it may be presumed that wheat was sown unusually early, yet the result could scarcely have been more disastrous. I am not prepared to say that nothing can be gained by this course, but in view of the experiences of the past season, I do not see how we can place much reliance upon this method of escaping the ravage of the chinch-bug.

"In this connection we may advert to the plan of sowing certain stimulating substances, such as salt and lime, with the seed, for the purpose of hastening the growth and the ripening of the grain. It has also been supposed that a pretty heavy dressing with such materials might render the soil obnoxious to the bugs. I have known of attempts being made to protect corn from the bugs, by the application of salt and air-slacked lime, but without any visible effect, and it is not probable that any quantity of such substances which we could reasonably apply to the soil would be effective in preserving our crops from these insects. But in the other point of view, that of hastening the ripening of the grain and thus placing it in advance of the depredations of the bugs, this plan seems to me to be well worthy of a trial. I was informed by a farmer living in Dixon that he tried sowing salt with his spring wheat, at the rate of one barrel to two and a half acres, and that upon the field so treated the crop was much larger than on the other portions, and ten or twelve days earlier. The effects of the salt will differ, of course, to some extent, like other applications, according to nature and condition of soil.

"The attempt to save a part of our crops by preventing the migration of the bugs from one field to another.

"It is well known that when the small grains become too mature and dry to afford nutriment to the chinch-bugs they migrate in vast numbers into the adjoining corn-fields, and generally destroy from a half dozen to a dozen or more of the outer rows, and nothing but the great extent of the fields of the West and the exuberance of the plants, which at this time have nearly completed their growth, preserve the corn-crop from the same destruction which has overtaken the smaller grains.

"As this migration takes place before the young brood have acquired wings, they necessarily travel on foot, and various attempts have been made to intercept their progress. The principal of these are a succession of furrows plowed across their path, and a barricade of fence-boards besmeared with coal-tar or kerosene-oil. The first plan, but very

partially successful, is so simple and easy of execution that it is always worthy of trial. I was informed by some farmers who practiced it the past season that it very materially checked their progress for the first day or two, so long as the furrow was fresh and the earth friable; but that a shower of rain or heavy dew for a succession of nights so consolidated the earth that the insects could pass over.

"The other plan is much more effective, but also much more troublesome and expensive. It consists of a barricade of fence-boards placed end to end and set edgewise into the ground, with the upper edge besmeared with some offensive substance, the one most commonly used being coal-tar. This method has been extensively resorted to the past season in the central part of the State, and especially in the neighborhood of the Bloomington gas-works, where the coal-tar is extensively manufactured. I was informed by one of the proprietors of the gas-works that nearly one hundred and fifty barrels of tar had been purchased at that establishment for this purpose. I had an opportunity of seeing this method put in practice, on a large scale, on the farm of Mr. Joshua Sells, of Bloomington. At the time of my visit Mr. Sells had discarded the boards as an unnecessary trouble and expense, and had adopted the simple and more expeditious plan of running a stream of tar from the spout of an old tea-kettle directly upon the ground along the exposed sides of his corn fields. He found that a gallon of tar would extend about ten rods, so that a two-gallon kettle twice filled would furnish a strip of tarred ground the whole length of a forty-rod corn-field. The tar had to be renewed every other day, and oftener in case of rain. The insects would crowd up to the line in such numbers that in many places they would pile up from half an inch to an inch deep, and could be scraped up by the double handful. But so long as the tar was kept fresh not a bug would cross it. They were not prevented from crossing by the adhesive nature of the tar, but by its repulsiveness. The bugs would not touch it. They were destroyed by conducting them into perpendicular holes, or by shoveling them in and burying them. The usual price of coal-tar at the gas-works is about two dollars a barrel. This is the most effective means yet resorted to for intercepting the progress of these insects when in the act of moving from one field to another; but the trouble and expense of using it, especially at a distance from the places where the tar is manufactured, will probably prevent its ever being very generally practiced. The great deficiency of all such methods as a remedy for the chinch-bug is that, at best, they only protect that crop which is usually the least damaged by them.

"The method of destroying the insects by burning corn-stalks and other rubbish in which they are supposed to hibernate.

"We have just adverted to the fact that when the small grains fail the chinch-bugs migrate into the corn, and that at this time they travel on foot and confine themselves mostly to the outer rows. But shortly after this the young bugs acquire wings and then spread themselves over the fields in large flocks. It is a question of considerable importance, and one to which but little attention has been paid, whether these insects materially damage the corn-crop after this general scattering of themselves, in the latter part of summer. From the circumstances of the case, this question does not admit of a very easy solution. The fact that these insects require comparatively little nutriment after they have attained their winged and mature state, taken in connection with the

vast extent and luxuriance of the western corn-fields, and with the additional consideration that, the crop being at this time considerably advanced, the loss would be only comparative and therefore not easily discriminated—all this tends to involve the subject in much uncertainty.

“Mr. George W. Patten, of Delavan, Tazewell County, at whose house I visited in the height of the chinch-bug season, actively co-operated with me in the determination of this and other matters appertaining to these destructive insects. Mr. Patten took the pains to visit many of the farmers in his own and the neighboring counties, all of which were badly infested, for the purpose of making inquiries upon this point. He found it to be the general opinion that the bugs had damaged the crop very sensibly. As the whole State has suffered severely the past season for the want of rain, there was the additional difficulty in this case of distinguishing between the effects of the drought and that caused by the bugs. The insects themselves, however, furnish a key to the solution of this difficulty, by virtue of their gregarious habits. It appears that they do not scatter themselves indiscriminately over the field, but that they move in large flocks, not unlike their fellow-depredators, the blackbirds. Accordingly the corn-fields are found to be damaged in patches, and it is thought to a sufficient extent to materially diminish the crop.

“This general diffusion of the chinch-bugs over the corn-fields after midsummer, taken in connection with the common observation that they remain there until late in the fall, has naturally suggested the expediency of gathering the stalks together and burning them, after the corn has been harvested, with the view of destroying the bugs. It has also been advised, in order to make the remedy more sure, to burn the dead grass and other rubbish which accumulates around the borders of fields and fences. My own observations have led me to the conclusion that this remedy also, in the way that it would be likely to be generally put in practice, can be of but little avail. Upon examining an infested corn-field late in October, I found that the bugs had left the upper part of the stalks and had collected about the one or two lowermost joints, under the sheaths of which they were congregated. They had gone thither partly perhaps to avoid exposure to the cold winds of approaching winter, but chiefly, no doubt, for the sake of the nutriment which they could still extract from the lower joints of the stalks after the upper ones had become dead and dry. Upon visiting the same field a month later (November 22), after winter had virtually set in, the mercury standing 15° above zero, the ground whitened with snow, after cattle had had the range of the field, very few bugs could be found. A few were found in deep cracks in the stalks, and a few were lying torpid upon the ground close to the roots of the corn. Upon digging up a number of hills no bugs could be found beneath the surface. Where the great majority of them had gone was not apparent. It is known that some of these insects hibernate under boards and flat stones lying loosely upon the ground, and similar situations. Dr. Shimer found many of them under the fallen leaves of apple trees, but nearly half of these were dead. I have heard of their being seen flying in flocks towards the woods late in the fall. I cannot vouch for the truth of this, but I found them this fall in small numbers under the loose bark of prostrate logs, in the edge of the woods, half a mile from any tillage land. I also found them congregated on the under side of some flat stones lying upon stubble land. Within a few rods from them was a ravine filled with long dead grass, but I could find no bugs among the grass. It is proper to say, however, that this last was not a badly infested locality.

"With the view of obtaining further observations upon this part of the subject, still later in the season, and especially in the badly infested district, I wrote to my friend Mr. Patten, whose assistance I have above been happy to acknowledge, and requested him to examine some of the corn-fields in his vicinity. From Mr. Patten's reply, under date of December 20, I extract the following valuable observations:

" 'Since the receipt of your letter, I have at different times examined corn-stalks with a view to finding chinch-bugs, but have not succeeded in finding a live one. I have a piece of ground sown to fall wheat, from which I had carried what few stalks of corn the bugs had left standing, and had thrown them in heaps along the edges of the field. These heaps I have been examining, and have always found large numbers of dead bugs, but no live ones. To-day it occurred to me that perhaps by bringing them into a room of proper temperature they might show signs of life; but after giving them a fair test I have been unable to bring any to life. In all shocked corn that was put in shock before the frost killed the corn, I find large numbers of dead bugs, from the ear down. In later-cut corn they do not seem to be so numerous. In the stalk-fields I find very few bugs, either dead or alive. To-day I chopped up stalks by the roots, examining each sheath from the ground up; then opened the stalks, both sound and fractured ones, but found nothing that could be recognized as ever having been a chinch-bug. That the bugs disappeared from their usual haunts upon the approach of severe cold weather, I am fully satisfied, but where they now are I have failed to ascertain. The first thought is that they have gone below the surface of the ground; but when we consider that our cold weather came so suddenly upon us that the first night the ground was frozen to the depth of three or four inches, it hardly seems possible that the chinch-bugs could have penetrated it.'

"Mr. Patten made the following curious observation bearing upon the hibernation of these insects:

" 'About the time of our first frosts, while gathering hazel-nuts in the timber, I observed that in nearly every instance where a nut had been bored into by an insect or grub, from one to four chinch-bugs had found their way into the nut. Whether they were there for winter quarters, or were feeding upon the partly consumed nut, was a question which I could not solve.'

"Mr. Patten concludes his letter with the following practical remarks:

" 'As to burning the stalks with a view to destroying the chinch-bugs, I have but little faith in it. Could the stalks be burned before excessive cold weather sets in, very probably a large portion of the bugs could be destroyed, but by the time the corn can be harvested and the stalks are dry enough to burn, the chinch-bugs have taken to their legs or wings and left for parts unknown.'

"What strikes us as remarkable in these statements of Mr. Patten is that all the chinch-bugs which he discovered appear to have been dead. The question arises, did they die a natural or unnatural death? Had they arrived at the natural term of their lives, or were they killed by the sudden accession of cold weather, or by some other and unknown cause? As many of these insects were found in tolerably well-protected situations, that is, under the sheaths of corn-stalks which had been laid in piles, it does not seem probable that they could have been killed by the first cold snap of winter. The most plausible explanation of the case I can give is that these dead insects were the old bugs of former broods which had arrived at the end of their natural lives, whilst the instincts of the new brood, which are to perpetuate the race in the suc-

ceeding year, had led them to seek out more secure and permanent retreats.

"From all this we conclude that late in the fall, and when winter is about to set in, chinch-bugs, like most other insects, seek secure and hidden retreats where they will not be exposed to the snows of winter nor the cold rains of the fall and spring, and therefore that the burning of corn-stalks or other loose rubbish, late in the fall, will destroy but a very small proportion of them. The only way to accomplish this end to any considerable extent would be to husk the corn as early as possible, and then cut off the stalks close to the ground and burn them. But even here it is very questionable whether the bugs would not leave the stalks before they were dry enough to burn. But in any event, the plan is scarcely available in actual practice. In the first place, most farmers depend upon their stalks for fall feed for their cattle; and if a farmer should conclude to sacrifice his stalks for this purpose it would insure him no immunity from the inroads of the insects in the spring from surrounding localities.

"It may seem to be poor encouragement to show that the plans and preventives upon which we have been taught chiefly to rely, for checking the ravages of this formidable insect, are of little real efficacy. But it is best to know the truth and to see the evil in its true proportions. The first step to take in meeting a real danger is to divest ourselves of all false securities.

"The prevention of their breeding to any serious extent by abstaining from the cultivation of those grains upon which they chiefly subsist.

"If, then, our supposed remedies for the chinch-bug prove in a great measure fallacious; if experience shows that we cannot get our grain into the ground so early but that the bugs will be even with us; if plowed furrows and tarred barricades can only be resorted to when most of the mischief has been done; and if these insects hide themselves so securely in winter that burning corn-stalks and other rubbish can destroy, at best, but a very small proportion of them; and, finally, if their natural enemies are so few as to make no perceptible impression upon their countless hosts, then we are driven to inquire, with the more earnestness, whether we can take a step in advance of all these imperfect palliatives, and absolutely prevent the breeding of these noxious insects, to any serious extent, by abstaining from the cultivation of those crops which are most congenial to their nature. It may seem a hard alternative to give up the raising of some of our most valuable crops at the behest of these nauseous *Hemiptera*, but a hard remedy is better than no remedy. It is better to save your labor and your seed than to lose seed and labor and harvest likewise.

"What, then, does experience teach us with regard to the breeding-habits of these insects and the plants upon which they mostly subsist?

"When the warmth of spring has become sufficiently confirmed to penetrate the hidden recesses where insects hibernate, many different species which have wintered over in the winged state are seen emerging from their retreats and launching out upon the vernal air, apparently rejoicing in their new lease of active existence. Among these, in the localities where they prevail, the chinch-bugs are to be seen, flying in dense flocks, in search of the plants at the roots of which it is their instinct to deposit their eggs. Mr. Sells, of Bloomington, informed me that whilst plowing about the first of May his clothing and his horses were thickly sprinkled over with them, and that the horses were

seriously annoyed in breathing by the bugs flying into their nostrils. These insects deposit their eggs at the roots of our cultivated cereals and some of the grasses which most nearly resemble them. As the chinch-bug is a native insect, it must have subsisted originally upon the native grasses before the cultivated cereals were introduced. The chinch-bug was then a rare insect, only occasionally met with by collectors. Mr. Thomas Say, who spent twenty years in collecting and describing insects in many parts of the United States and their Territories, first described the chinch-bug from a single specimen, and the only one he had ever seen, and which was captured in the eastern part of Virginia. But there is no difficulty in obtaining specimens now. We have ourselves been the means of their excessive multiplication, by furnishing them with a superabundance of congenial food in the shape of our cultivated grains.

"But the question now before us is, upon which of these grains do they thrive best, and will they thrive sufficiently upon all of them to multiply to a serious extent, or are they restricted in their food-plants to such a degree that we have it in our power to get rid of them at any time by abandoning the cultivation of some one or more of these grains.

"It seems remarkable that these insects should make a selection between plants so similar, both in nature and appearance, as are several species of what are known as the small grains. Yet abundant experience has taught us that they do make a very decided selection. It is known that they always give a strong preference to spring wheat and barley, where these are at hand. Where these two grains are not available, they will oviposit upon either of the others, and perhaps to about an equal extent. We know this from the fact that all of these grains are sometimes considerably injured where chinch-bugs abound, and the chief reason, probably, why winter wheat does not suffer as much as spring wheat is that this crop gets nearly matured before the new brood of bugs makes its appearance, and accordingly we sometimes see late pieces of winter wheat almost as much damaged by them as the spring wheat. But the main question is whether, if no spring wheat or barley be raised, the chinch-bugs will continue to thrive and multiply to excess upon any other kinds of grain. The general opinion is that they will not. And yet a sufficient number of exceptional cases occur to throw some doubt upon the matter, and to induce some farmers to hold the opposite opinion. Chinch-bugs are, in some years, found in considerable numbers in the southern part of this State, where the winter grains exclusively are raised. A number of cases, also, like the following have come to my knowledge:

"Mr. D. Veatch, of Livingston County, stated to me that winter wheat, oats, and corn were all seriously damaged in his neighborhood, though but little spring wheat was raised; and on his own farm a field of thirty-six acres of oats was not worth harvesting, though no spring wheat had been raised in its vicinity for the last five years. And a somewhat similar case was related to me by a Mr. Vail, of Tazewell County. More definite testimony is needed upon this subject. My opinion, from my present knowledge, is that such cases are rare and exceptional, and perhaps could be easily explained if we knew all the circumstances.

"From the foregoing observations we draw the following practical conclusions:

"1st. That it is useless to attempt to raise spring wheat or barley where chinch-bugs have been present in any considerable numbers the preceding year, unless we have reason to believe that they have been killed off by heavy rains.

"2d. That in case the season should be favorable to the propagation of the chinch-bug, we always have it in our power to get rid of these pests by the abandonment of these two kinds of grains for one or two years. But to make this course effective there must be a concert of action by farmers over a considerable section of country.

"3d. That the presence of chinch-bugs the preceding year will not prevent the raising of corn or any of the winter grains.

"4th. With regard to oats, the testimony thus far is that if this grain be sown where chinch-bugs abound, and especially if it be sown exclusively, it will be damaged to a greater or less extent the first year, but that the bugs probably will not continue to breed in it to any great extent in succeeding years.

" Other proposed remedies.

"It may be proper before closing to advert briefly to a few of the more plausible of the other remedies for the chinch-bug which have been suggested. It has been proposed to burn over the infested and ruined grain-fields just before the time for the bugs to leave them, with the view of destroying the bugs and thus preventing their migration into the corn. This is a good suggestion, provided the grain is dry enough to burn before the bugs leave it; and, also, provided it will burn low enough to kill the bugs, which in this case would all drop to the ground. The plan would be most likely to succeed by the aid of dry straw and favorable condition of wind and drought.

"Another plan which has been proposed is to sow a small proportion of winter rye (one bushel to twelve) with the spring wheat, with the expectation that the bugs would feed upon the green rye near the ground, whilst the more rapidly growing wheat would rise above it and come to maturity. This suggestion is founded upon the mistaken notion that the chinch-bugs feed upon the green blades of the grain, whereas they imbibe their nutriment first from the roots, and afterwards from the lower joints of the stalk.

"The well-attested fact that chinch-bugs are checked in their operations by rain induced Dr. Fitch to advise the sprinkling of wheat-fields—or at least those parts of them where the bugs first made their appearance—with water, by means of a garden engine, or some other contrivance. This would be an interesting experiment where the field is very small and the supply of water abundant; but we presume the doctor would hardly recommend this plan as practicable on the forty thousand square miles of territory overrun this year by chinch-bugs at the West.

"All the attempts to check the depredations of the chinch-bugs by throwing offensive substances upon them, such as tarred saw-dust, salt, or lime, have proved to be labor lost. The recommendation of salt application had the run of the newspapers the past season. Both this and the air-slaked lime were thoroughly tried by Mr. Sells, of Bloomington, without making any perceptible impression upon the bugs."

Mr. O. B. Nichols, of Clinton County, Illinois, writing to the Prairie Farmer of December 2, 1858, gives the following as his plan for preventing their increase:

"My plan to keep clear of them is this: In the fall I plow under all the weeds and grass that I can get to with the plow. I have my fields so arranged that I can turn in my sheep and cattle to eat the weeds and grass out of the fence-corners before I sow my wheat, and in the bal-

ance of my fields I turn on during winter, and if I have any fence-corners that I cannot feed out, I take a torch, and the boys follow with buckets of water and tin cups, and I burn up the grass and weeds. I feed all my corn-fodder and straw to my cattle and other stock, whether they need it or not. I leave nothing on the place after the 1st of May for them (the bugs) to harbor in."

Although long ago recommended, and considered of doubtful utility by so good an entomologist as Dr. Le Baron, it is, in substance, as will be seen hereafter, what the present writer considers one of the most reliable practical remedies yet suggested.

Dr. Fitch, speaking of measures for destroying this pest or preventing its injuries, remarks as follows:

"Nor has any mode for destroying this insect or preventing its depredations been discovered of such efficacy as to bring it into public notice and favor. When they are migrating from one field to another, it has been reported that they have been arrested by digging a trench before them, up the crumbling dirt of the sides of which they are unable to climb; and when the whole colony is thus imprisoned, they have been covered with straw and burned. By burning the dry leaves of the forest in places where they have settled in numbers, multitudes have been destroyed. A subscriber to the *Southern Planter* (vol. xv, p. 275) says he knows that strong soap-suds will kill them, when on corn, if a half gill or gill be poured on each stalk; a labor not half so great as a single hoeing of the crop is. When this insect became so numerous in North Carolina, in 1839, Mr. J. W. Jeffreys proposed that the farmers and planters should all abandon the sowing of wheat for two or three years, he deeming this the only measure by which it was possible to subdue it. Dr. Le Baron thinks it improbable that any remedy can ever be discovered whereby to prevent its devastations. My own belief is very different. I do not think Providence has sent any injurious insect into our world but that when we come to study its history and habits, and become fully acquainted with its economy, we can discover some point where it is assailable, and human ingenuity will be able to devise methods by which it will be practicable either to destroy the insect or to shield the vegetation on which it preys from its depredations, though often, no doubt, much patient investigation and many experiments, conducted by different persons, will be necessary before we can arrive at the most certain and successful remedies.

"As regards the chinch-bug, if the facts reported are true, we think they point us to a feasible mode for subduing it. They indicate that moisture is most uncongenial to this insect. If, when it is overrunning the land in myriads, a wet season arrives, it is at once quelled in its career. Mr. Williams speaks of its ravages as having been perceptibly checked by a single heavy rain. And it appears from the statement of Mr. Albert Burnet that so slight a circumstance as the dew evaporating before the morning sun first upon the south and east sides of a field often causes it to congregate upon those sides of the field exclusively. In view of these facts it would seem that by drenching that part of a field in which these insects are clustered with water, by means of a fire or a garden engine, they may be washed from the plants and destroyed. Though it will be a formidable task to shower a large wheat-field profusely, yet if the crop can thereby be saved from ruin, it will amply repay the expense. But commonly it is only a narrow strip upon one side of the field which will require this operation. And where there is a

brook or stream of water passing through or adjacent to a wheat-field, this measure can certainly be resorted to, repeatedly should it be necessary, at no great cost. When the small red bugs, the tender young larvæ of these insects, have made their appearance and are clustered about the roots of wheat-plants in the month of June, they can probably be more easily destroyed than at any subsequent stage of their lives. And it is earnestly to be hoped that some one who is conveniently situated for testing the efficacy of this measure will do so and make the result known to the public."

Mr. Riley, although mentioning and discussing, in the article on the chinch-bug, in his seventh report, the various remedies against this pest, lays particular stress on irrigation as a means of destroying it, remarking as follows:

"When a field of wheat or barley or rye is once overrun with chinch-bugs, man is, in the majority of cases, powerless before the unsavory host, and his only hope is in timely rains. The great majority of noxious insects may be controlled even at the last hour, but a few—and among them is the chinch-bug—defy our efforts when once they are in full force upon us. There are several applications that will kill the insect when brought in contact with it, and I have known a few rows of corn to be saved by the copious use of simple hot water; but the application of all such direct remedies becomes impracticable on the scale in which they are needed in the grain-fields of the West. Irrigation, where it can be applied—and it can be in much of the territory in the vicinity of the Rocky Mountains, where the insect commits sad havoc, and with a little effort in many regions in the heart of the Mississippi Valley—is the only really available, practicable remedy, after the bugs have commenced multiplying in the spring. *I wish to lay particular stress on this matter of irrigation*, believing, as I do, that it is an effectual antidote against this pest, and that by overflowing a grain-field for a couple of days, or by saturating the ground for as many more in the month of May, we may effectually prevent its subsequent injuries. In the article on the Rocky Mountain locust I may have something more to say on this matter of irrigation. We cannot at the critical moment expect much aid from its natural enemies, for these are few, and attack it mostly in the winter time. We must, therefore, in our warfare with this pest, depend mainly on preventive measures where irrigation is impossible."

Having made observations in reference to the habits of this insect, and finding that it wintered in the perfect state, I suggested, in 1859, burning over the infested fields in the winter as perhaps the best means of destroying them, and am still inclined to look upon it as the best practical means of counteracting them that is susceptible of general adoption. Irrigation is undoubtedly the most effective method of destroying them wherever it can be practiced, and should in such favored situations supersede every other remedy. Unfortunately, in a very large part of our territory where this insect proves most destructive this remedy is not feasible, and hence some other must necessarily be adopted. But, as indicated in Mr. Riley's report, it is the only effectual means that can be resorted to in the spring after the bugs have commenced multiplying, unless the crop is sacrificed; hence the only plan the farmer can resort

to, to counteract them, where irrigation is impossible, consists in preventive measures. It is possible, as will hereafter be shown, to prevent in a large measure injury to corn by the second brood, owing to the peculiar habit of the species of migrating on foot.

Before discussing further the remedies to be adopted, let us consult the statistical reports and see which of the two great products, wheat and corn, suffers most from the depredations of this pest, in order that we may know for which these remedies are most needed. For this purpose we will limit our investigations to the Northwestern States, Indiana, Illinois, Missouri, Iowa, Wisconsin, Kansas, and Nebraska, and to the three great chinch-bug years, 1864, 1871, and 1874, as the statistics for these States and years are the most complete and will suffice for the object in view.

By taking the yield for the years 1870, 1871, and 1872, we shall be able to detect any material variation in the crop of 1871.

We use the crop statistics of the Agricultural Department.

Total yield of wheat.

	1870.	1871.	1872.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	20,200,000	19,190,000	19,351,000
Illinois	27,115,000	25,216,000	24,711,000
Missouri	6,750,000	12,825,000	7,695,000
Iowa	20,445,000	18,400,000	22,080,000
Wisconsin	20,485,000	18,436,000	22,307,000
Kansas	2,343,000	2,634,000	2,155,000
Nebraska	1,848,000	1,823,000	2,500,000
Total	99,186,000	98,530,000	100,829,000

Yield of wheat per acre.

	1870.	1871.	1872.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	11.0	12.0	12.4
Illinois	12.0	12.3	12.1
Missouri	13.0	13.4	8.8
Iowa	12.5	10.8	12.6
Wisconsin	13.4	12.2	14.3
Kansas	15.0	15.9	11.6
Nebraska	14.4	10.3	12.2
Average by States	13.04	12.41	12.0

Adopting a similar plan in reference to 1874, we find the yield of wheat in the same States, for 1873, 1874, 1875, as follows:

Total yield of wheat.

	1873.	1874.	1875.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	20,832,000	23,331,000	17,280,000
Illinois	28,417,000	30,122,000	27,900,000
Missouri	11,927,000	15,385,000	11,160,000
Iowa	34,600,000	33,908,000	29,800,000
Wisconsin	26,322,000	18,436,000	25,200,000
Kansas	4,330,000	9,455,000	(?) 12,700,000
Nebraska	3,584,000	3,619,000	3,400,000
Total	130,012,000	134,256,000	128,840,000

Yield of wheat per acre.

	1873.	1874.	1875.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	11.2	12.2	9.0
Illinois	13.5	11.5	10.5
Missouri	12.8	13.5	9.0
Iowa	13.0	11.6	9.7
Wisconsin	16.5	11.5	14.0
Kansas	14.0	13.7	(?) 17.0
Nebraska	15.5	11.6	9.8
Average by States	13.79	12.23	11.29

It is apparent from a glance at these tables that there was no marked variation in the wheat-crops of the Northwest in 1871 and 1874 which can be attributed to the depredations of the chinch-bug. But before discussing them we present the following similar tables in reference to the corn-crop:

Total yield of corn.

	1870.	1871.	1872.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	113,150,000	79,205,000	85,541,000
Illinois	201,378,000	203,391,000	217,628,000
Missouri	94,990,000	87,390,000	105,741,000
Iowa	93,415,000	99,019,000	101,989,000
Wisconsin	19,995,000	21,394,000	21,180,000
Kansas	18,685,000	24,693,000	29,631,000
Nebraska	5,163,000	7,228,000	7,589,000
Total	544,776,000	522,320,000	569,299,000

Yield of corn per acre.

	1870.	1871.	1872.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	39.5	35.7	38.7
Illinois	35.2	38.3	39.8
Missouri	31.4	38.0	37.0
Iowa	32.0	42.5	39.8
Wisconsin	38.0	37.7	38.0
Kansas	28.0	40.0	38.5
Nebraska	30.0	41.5	37.8
Average by States	33.44	39.10	38.51

Total yield of corn.

	1873.	1874.	1875.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	67,840,000	74,624,000	95,000,000
Illinois	143,634,000	133,579,000	280,000,000
Missouri	70,846,000	46,049,000	123,000,000
Iowa	105,200,000	115,720,000	160,000,000
Wisconsin	18,308,000	15,492,000	15,200,000
Kansas	47,000,000	16,065,000	76,700,000
Nebraska	7,000,000	8,500,000	28,000,000
Total	457,828,000	405,029,000	782,900,000

Yield of corn per acre.

	1873.	1874.	1875.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Indiana	25.6	27.0	24.0
Illinois	21.0	18.0	24.3
Missouri	23.5	16.0	26.6
Iowa	26.0	22.2	35.0
Wisconsin	30.0	23.2	21.0
Kansas	32.1	10.5	40.0
Nebraska	25.0	10.0	40.0
Average by States	29.08	19.84	34.41

Although fully aware that the crop statistics as given in the annual reports of the Agricultural Department are far from being as accurate as desirable, yet they are as good as can be obtained by the means at the disposal of that department, and are moreover our only source of information on the subject. From some investigations I have made in my own State, I am inclined to think that as a rule they are in excess of the true figures, but on the whole approximate sufficiently near the true amounts for all ordinary or general purposes. I prefer, therefore, to rely upon them as a basis of calculation, rather than the unofficial statements given by others.

Taking these as our guide, we see at a glance, as before remarked, that so far as the yield of wheat was concerned, in 1871 and 1874, the depredations of the chinch-bug in the States named, although these are the ones in which it was most abundant, had no marked effect. Although the aggregate amount produced in 1871 was a little less than that of 1870 or 1872, yet the yield per acre was actually a little more than in 1872, and but three-fifths of a bushel less than that of 1870. It is, therefore, more than probable that the calculations of Dr. Le Baron and others in reference to the loss on wheat in 1871 is largely in excess of the correct amount, and was probably made up chiefly from the guesses of correspondents, and assuming the destruction was equal in all parts of the area embraced. The same thing may be said in reference to the calculations of Dr. Shimer and others in reference to the loss in 1864, for in Illinois, to which State these chiefly referred, the yield of wheat in 1864 was, according to the statistical report, actually 3.5 bushels more per acre than in 1865, and the total amount nearly 8,000,000 bushels more; but in reference to corn the case was reversed. In these earlier calculations another cause of error arose from the fact that no reference was made to these statistical reports as checks and guides. I have no doubt but that the loss occasioned by this insect in 1874 was far greater than in any previous year, yet Mr. Riley in reference to Missouri, and the writer in reference to Illinois, applying these checks so as to eliminate error as far as possible, although finding the loss truly alarming, produced no such figures as the calculations relating to 1864 and 1871. We also found that the loss on wheat was confined chiefly to the spring variety, and was really much less than had been supposed, though of

sufficient importance to demand the attention of agriculturists and the government, running up in some years to millions of dollars. For, notwithstanding the showing of the statistical report, that this insect did, in 1864, 1871, and 1874, destroy large amounts of wheat, especially in the spring-wheat belt, is too well known to be controverted by any statistics.

There are strong reasons for believing that the habits of the species have somewhat changed since it first came into notice as injurious; so that instead of being more destructive to the wheat-crop, as formerly, it is now more injurious to corn. A farmer writing to the *Prairie Farmer*, October 18, 1873, makes the following statement on this point:

"I have, as a farmer, suffered from the ravages of the chinch-bug for twenty-eight years; it has steadily increased in numbers. While at first it only injured oats and spring wheat, it now swarms in our corn-fields and injures our fall wheat. * * * I have seen corn not more than six inches high destroyed by them. Years ago it was generally thought, where I then resided, that we should have to stop raising spring wheat to get clear of them, as it was then the only crop seriously injured; now we would have to make our land a desert to starve them out.

If we turn now to the corn statistics we shall find that so far as the Northwest is concerned this is the crop that suffers most from this pest, and that in some years the loss, estimated by the most careful rules, is absolutely enormous.

Even in 1864 the effect of this insect on this crop is manifest in the statistics; to show this we present a table showing the production of the States named, for the years 1864 and 1865.

Total yield of corn.

States.	1864.	1865.
	<i>Bushels.</i>	<i>Bushels.</i>
Indiana.....	74, 284, 363	116, 090, 316
Illinois.....	138, 354, 135	177, 095, 862
Missouri.....	36, 635, 011	52, 021, 715
Iowa.....	55, 261, 240	62, 997, 613
Wisconsin.....	10, 087, 053	15, 449, 405
Kansas.....	4, 673, 081	6, 729, 234
Nebraska.....	1, 366, 622	2, 494, 064
Total.....	320, 663, 505	430, 857, 421

Yield of corn per acre.

States.	1864.	1865.
	<i>Bushels.</i>	<i>Bushels.</i>
Indiana.....	29	40. 6
Illinois.....	33	35. 2
Missouri.....	26. 8	39
Iowa.....	36. 7	42. 7
Wisconsin.....	31	41. 5
Kansas.....	25	41. 2
Nebraska.....	28. 5	46. 5
Average by States.....	30	40. 95

Here we see a difference of 10 bushels per acre in favor of 1865, showing a loss in 1864, after allowing for the difference in acreage, of about 100,000,000 bushels, which was largely owing to the chinch-bug.

The statistics of 1871, it is true, fail to show any marked loss; in fact, the yield per acre, as shown, was larger this year than in 1870 or 1872, but there was evidently some change in the method of computing the acreage, probably caused by the census returns for 1870, and hence it is impossible to make a true comparison in this respect. But even making allowances for this, the loss in the corn-crop does not appear to have been severe except in Indiana, which could not have been very largely owing to the depredations of the chinch-bug.

On the contrary, the statistics for 1873, 1874, and 1875, as above given, bring out very clearly the loss in 1874 to this crop. The yield per acre in 1874 was nearly 10 bushels less than in 1873 and nearly 15 bushels less than 1875. If we take the acreage in 1874 and estimate the yield at but 30 bushels per acre, which is but seven-tenths of a bushel more than in 1873 and nearly $4\frac{1}{2}$ less than 1875, we shall find the aggregate loss to have been a little over 200,000,000 bushels. By comparison with the loss on this crop in other States in 1874, we find that about 40 per cent. of it is to be attributed to the drought of that season, the remaining 60 per cent. almost entirely to insects, the chinch-bug and grasshoppers, or locusts. Here, then, is a loss on corn alone in these seven States in one season by insects of some forty or fifty millions of dollars. Indiana, Illinois, Wisconsin, Eastern Missouri, and Eastern Iowa sustained more than two-thirds of the entire loss, and this was occasioned by the chinch-bug.

It is evident, therefore, from these facts, that while the loss to the wheat-crop occasioned by this insect is large, it is greatly exceeded by that to the corn-crop.

Let us now return to the consideration of the means to be adopted for their destruction and preventing their depredations.

BURNING.—As the bugs from which the future generations are to be developed hibernate in the perfect state, as has heretofore been shown, it is evident that if these can be destroyed their development will be prevented, and for each female destroyed, which sex is largely in excess of the males at this season, numbers of the spring brood will virtually be exterminated. It should also be remembered that at this time their number is reduced to a minimum and that they are quiescent. If it is possible, therefore, to reach their retreat with fire, this will be the most effectual method of destroying them where irrigation is impracticable.

But Dr. Le Baron, as we have seen, believes this will be ineffectual, because the bugs, as he finds, do not remain on the cornstalks during the winter, but seek other quarters in which to hibernate. That they do so where the corn is not cut and shocked is undoubtedly true to a very large extent. I have also observed the same fact, mentioned by Mr. Patten, that to a large extent those found after winter sets in under

sheaths of the lower joints of the stalks are generally dead. These, I think, are chiefly the males; possibly they are, as he suggests, in part, at least, the old ones of the preceding brood. Although, when hard pressed, they sometimes hide beneath the clods, yet this is the exception and not the rule; they seek shelter wherever it can be found in and around the field. So far, therefore, as it is possible to do so, fire should be carried to these surrounding hiding places. In timbered sections the leaves should be burned, and, as was Mr. Nichols's custom, the fence corners should be cleaned and burned. Although a large number, on account of the impossibility of reaching them, will escape, yet, if this method is thoroughly carried out, the greater portion will be destroyed.

But in order that this remedy may be effectual all the farmers in the infested district must act in concert; otherwise the labor of one will be rendered valueless by the neglect of another.

In order that this concert of action may be brought about, it might be well for the States infested by this pest to enact laws giving the officers of towns or counties authority when danger was apprehended to compel action. But this need not be done annually, as our knowledge of the habits of the insect is sufficient, if properly used, to give us warning of the danger. Two successive favorable—that is, dry—years are required to develop them in sufficient numbers to cause any serious injury. In the winter following a rainy season they will be reduced to a minimum in respect to numbers, and although the following season may be dry, they cannot increase to the same extent possible when two favorable seasons come in succession. The second brood may excite some alarm, but it will not be sufficiently numerous to inflict any serious injury. It is also evident that four successive broods, without any counteracting influence to check them, will produce more than two broods.

If the season has been dry, and an examination in the fall shows them to be present in considerable numbers, although they have done no material injury nor even attracted general attention, yet it may be set down as probable, in fact almost certain, that if the next is dry, unless killed by an unusual winter, they may be expected in destructive numbers. It is true that they sometimes appear in great numbers when no complaint has been made the previous season; but if a careful examination had been made the numbers hidden from the cursory glance would have caused apprehension of danger.

If the season is wet examination is unnecessary, but if it is dry search for them should be made by every farmer in the fall before cold weather sets in, and in and around every field where found, as soon as it is possible to do so, every hiding place should be subjected to a fiery ordeal. Dr. Le Baron suggests that the farmers need the stalks for fodder, but it is better to sacrifice them one season than to abstain from sowing small grain.

When they are in sufficient numbers to do serious injury or excite apprehension of danger from them the next season, it might be well to adopt

the southern plan of topping the corn. This will cause the grain to harden more rapidly and the stalk to dry the sooner, so that the corn can be gathered at an earlier day, when the stalks can be cut and raked into windrows and burned before the bugs have left them.

Mr. Riley recommends that "shocks should be made at intervals to attract the bugs. The bugs will then congregate in these shocks, which may be burned at any time during the winter"—after the ears have been removed. As confirming this opinion he quotes the following from a letter of one of his correspondents: "The most compact and destructive army of chinch-bugs I ever saw started from sorghum bagasse which had been used as manure. Might the insects be trapped to any extent worth mentioning by exposing heaps of rubbish in conspicuous places in August, and burning the same in November?"

If it is found at the time wheat is harvested that the bugs have not taken their departure, as in the case in the winter-wheat section, this fact may be taken advantage of to destroy a very large portion of them. If the wheat is at once threshed and the straw scattered over the stubble and burned, it will destroy all or most of those that are there. I know of one section in Southern Illinois where this has been practiced for a number of years by the German farmers with good results.

Further information is desired in reference to the time the migrations take place in the different sections of the country, especially whether this is usually before or after wheat harvest. As there is a difference in this respect, it is desirable to ascertain the boundary line between the sections; to know whether it varies according to kind of wheat that is raised, spring or winter, or according to latitude.

It would seem that a thing apparently so easily ascertained, and which has been so often observed, ought to be generally known; but it appears to have been overlooked by those writing in reference to the chinch-bug and its habits.

My personal observations of the habits of the species have been confined to the winter-wheat belt, where it is usually, and so far as I know universally, the case that they migrate after harvest. This fact should therefore be taken advantage of by the farmers within that region, as it affords them an excellent means of destroying this pest.

ABSTAINING FROM THE CULTIVATION OF GRAIN FOR ONE OR TWO SEASONS.

This measure is somewhat fully discussed by Dr. Le Baron in the extract heretofore given from his second report. His suggestion only applies to the small grains and chiefly to spring wheat. But aside from the impossibility of carrying out this plan, I have serious doubts whether it will be of any real advantage if we take into consideration the loss of the crop. That it will be of no permanent benefit I think must be admitted by every one who is acquainted with the habits of the species. However, as remarked by the Prairie Farmer correspondent, whose

words have been already quoted, in order that this remedy be made effectual it would be necessary to transform our land into a desert.

It is unnecessary, therefore, to discuss this remedy.

ROLLING.—Mr Riley makes the following remarks in reference to this remedy:

“As the mother chinch-bug has to work her way under ground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once that the looser the soil is at this time of the year the greater the facilities which are offered for the operation. Hence the great advantage of plowing land for spring grain in the preceding autumn, or, if plowed in the spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn ground, without any plowing at all, is far less infested by chinch-bug than wheat upon land that has been plowed.”

EARLY SOWING.—As Dr. Le Baron has discussed this proposed measure somewhat thoroughly, it is unnecessary for me to advert to it except to add that it might be well for the farmer in the northern portion of the chinch-bug belt to push the line of winter wheat as far northward as possible. By judicious selections it may be possible to obtain varieties which will be adapted to more northern climates than those now in use. There are some objections to this which may possibly outweigh the supposed advantage; one is the greater liability to injury by the Hessian Fly.

So far as corn is concerned, I believe that, as a rule which has but few exceptions, the sooner it is planted after the spring is fairly opened, and the ground is properly prepared, the better.

The more vigorous the growth of either crop the less will be the injury by the bug; even if they could exist in a damp season, when the plants are strong and healthy, the damage occasioned by them would be slight compared to what it is in a dry year, when the plants are enfeebled by a lack of moisture. On this account it is desirable that the hardiest varieties, or such as can best withstand drought, should be used.

OTHER REMEDIES.—It has been suggested that it might be of advantage to sow a strip of spring wheat around a field of winter wheat, so that when the bugs have sucked it dry, or as soon as the winter wheat is cut, and before the bugs have commenced to migrate to the corn, the spring wheat may be burned.

Some have tried surrounding other crops with Hungarian grass or millet, hoping to retain the bugs in it; but none of these expedients have proven of sufficient advantage to warrant the trouble and expense. Now and then there has been an exception, but the result has generally been as stated.

Topical remedies, such as the application of lime, salt, tarred sawdust, and other similar substances, will prove, as Dr. Le Baron has well remarked, “labor lost.” That it is possible to destroy them by the use

of hot water and certain acrid liquid substances is undoubtedly true, but such remedies can be profitably used only on a small scale, as in the garden. Thorough drenching with water at the proper season, as recommended by Dr. Fitch, will also destroy them; but all such remedies are inapplicable to field culture, as the expense would far exceed the value of the crop to be raised.

REMEDIES FOR THE PROTECTION OF THE CORN-CROP.—Fortunately for the farmer, nature has so arranged it that the summer brood, when compelled to migrate in search of food, either from necessity or preference, move on foot. As they all go together or in bodies when the movement commences, and usually in the same direction, it is apparent that if an obstruction of any kind can be placed in their way so as to retard their progress this will mass them in a comparatively small space and render their destruction much easier than when scattered through the fields. If the obstruction can be made to effectually bar their progress, they will be compelled to seek food elsewhere or perish. Farmers aware of this fact from their observations have had recourse to a number of expedients to accomplish this desired end to save their corn-crop, which is the one that chiefly suffers from the migrating hordes.

One of the devices employed is to set up boards edgewise around the field or along the side which the bugs are approaching, and besmear them with tar or kerosene. As this plan is described in Dr. Le Baron's notes, already quoted, it is unnecessary to note it farther than to say that although, perhaps, one of the most effectual bars to their progress, the expense and difficulty, in some places, of procuring plank and tar just at the time they are needed will prevent its being extensively adopted.

Another and more common method of stopping their progress is to plow a narrow strip around the field, keep it well pulverized by harrowing and rolling, then plow one or two furrows in this dusty strip. This should be done every day or two, care being taken to keep the strip as thoroughly pulverized as possible, as the bugs cannot travel well through the dust. The philosophy of this plan is, that as the bug attempts to crawl up the sides of the dusty furrows the loose particles give way and they roll back to the bottom. If they accumulate in the furrows a log or stone must be drawn through them so as to crush and destroy them. As it is always, probably without exception, dry weather when they migrate, and the soil dry, it is not difficult to keep the plowed strip pulverized if the clods are well crushed at first by rolling with a heavy roller where the soil is clayey.

Ditching is sometimes resorted to, but in this case care should be taken to have the side next the field perpendicular, and it would be well to drag a stone, log, or bundle of brush though it as soon as made, so as to rub the sides and somewhat pulverize them or render them dusty.

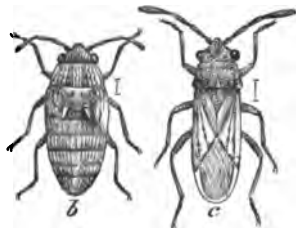
As they generally confine their operations for a time to the first few rows of corn of the field they attack, it is possible to destroy a large number of them by applying hot water, and this has in some instances

been successfully practiced, but the labor and expense are generally too great to justify it.

REMARKS.—Clean farming is the best under all circumstances, and, if adopted as a rule, will tend largely toward preventing the increase not only of chinch-bugs, but of all other injurious insects that trouble the farmer. But one of the best methods of preventing their increase is diversified farming. Massing crops in immense bodies and cultivating the same thing year after year on the same ground, as is so often done, necessarily tends to increase the insects that feed on these crops. An increase in one locality of any one plant brings a proportional increase of its insect enemies as a direct effect, and these are increased in a geometrical ratio if the plant is allowed to occupy the same locality for a number of seasons in succession. The only offset in this case is a like increase of the peculiar parasites that prey upon these insects, but in the case of the chinch-bug nature has favored man with no such friends, as it has no true parasite. So long as this violation of natural laws and, I might say, of the true theory of the farmer's profession is continued, so long will it be necessary to war with increasing hosts of insect foes. Enlarging farms and increasing crops will of necessity bring these evils; reverse the system, divide the farms, and diversify the farming, and it will be far less difficult for the farmers to cope with their insect foes. The disposition in our country, especially in the West and South, to obtain and operate large farms by machinery is one of the evils of our agricultural system. It is to our interest as a nation to multiply farms, to divide the land into as small parcels as possible, to draw the population from the cities into the rural districts, instead of just the reverse, as is the effect of the present system. Small farms and diversified farming is one of the best means not only of counteracting the numerous insect foes with which the farmers have to contend, but also to alleviate or prevent a number of other evils which society has to suffer. But I fear it will be more difficult to bring about this state of things than even to put into operation Dr. Le Baron's suggestion.

Before closing, I would call the attention of those agriculturists into whose hands this bulletin may fall to the fact that there are other species of insects which are sometimes mistaken for the chinch-bug. These are generally of the same order or sub-order as that to which the chinch-bug belongs, viz, *Heteroptera*. The one which bears the strongest resemblance to this noted pest is the false chinch-bug (*Nysius destructor* Riley, Fig. 9). This species appears to have fully as wide a range as the true chinch-bug and over the same area. In the perfect state it is shaped much like the true chinch-bug, and bears a somewhat strong general resemblance to it, though differing materially when closely examined. It varies in length from one-tenth to one-eighth of an inch to the tips of the wings, is of a gray-

Fig. 9.



False Chinch-bug.—b, pupa; c, mature bug.

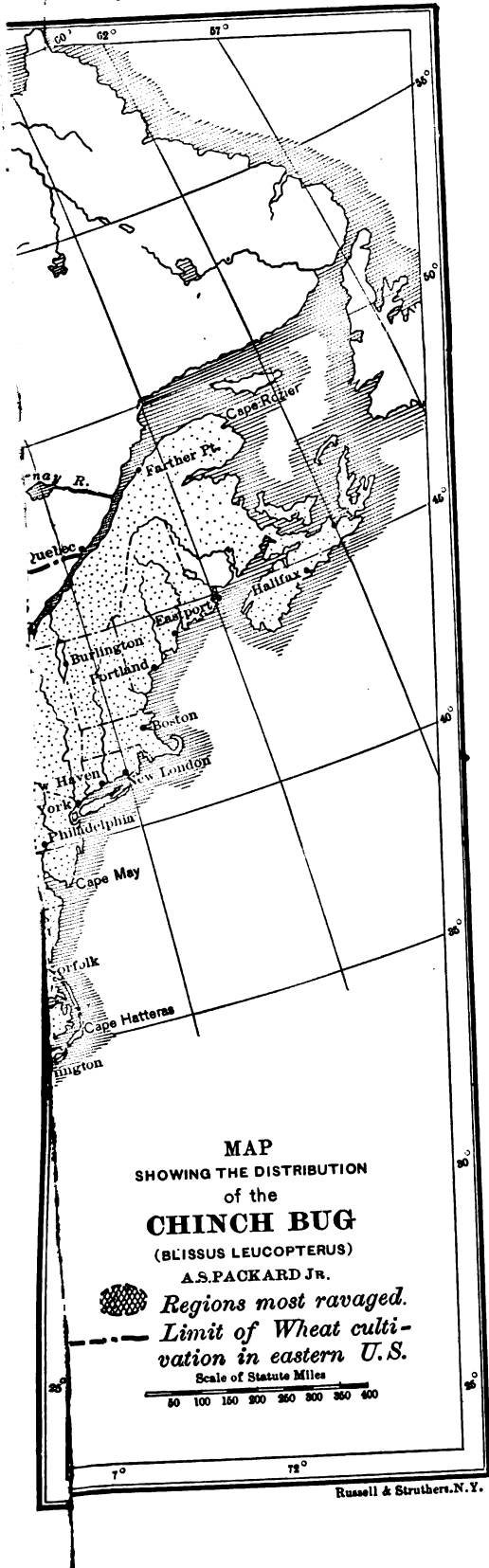
ish-brown color, the antennæ pale, with the fourth joint enlarged and as long as the third; the elytra or upper wings pale, and usually more or less tinged with dirty yellow on the basal portion; the legs pale yellowish, with brownish thighs. Like the true bug, it hibernates in the perfect state. In the summer it is frequently found on various wild flowers and small fruits. It is also fond of purslane.



A second species, the ash-gray leaf-bug (*Piezma cinerea* Say, Fig. 10), according to Mr. Riley, is also often mistaken for the chinch-bug. It is of a greenish-gray color, about one-sixth of an inch long, and is flatter and broader than the true pest.

As one object of this bulletin is to call attention to this injurious insect and gather facts for a further report, it is hoped that any one into whose hands a copy may fall, who has information to communicate, will do so by addressing the writer at *Carbondale, Illinois*.

C



Russell & Struthers, N.Y.



44

ish-

3
2
A

Ash

bro

A

inse

intc

will

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 6.

GENERAL INDEX

AND

SUPPLEMENT

TO THE

NINE REPORTS

ON THE

INSECTS OF MISSOURI.

BY

CHARLES V. RILEY, M. A., Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

MARCH 24, 1881.

C. V. RILEY, *Chief.*

A. S. PACKARD, JR., *Secretary.*

CYRUS THOMAS, *Disbursing Agent.*

ORDER OF MATTER.

1. INTRODUCTION.
2. TABLE OF CONTENTS.
3. CORRECTIONS.
4. NOTES AND ADDITIONS.
5. DESCRIPTIONS OF NEW SPECIES AND VARIETIES.
6. LIST OF DESCRIPTIONS OF ADOLESCENT STATES.
7. LIST OF DESCRIPTIONS, MOSTLY AMPLIFIED, OF SPECIES NOT NEW.
8. LIST OF ILLUSTRATIONS BY REPORTS.
9. CLASSIFIED LIST OF ILLUSTRATIONS.
10. GENERAL INDEX.
11. INDEX TO FOOD-PLANTS.

INTRODUCTION.

The present Bulletin has been prepared in response to frequent suggestions from those having occasion to use the nine Annual Reports on the Insects of Missouri, made by me, as State Entomologist, to the State Board of Agriculture, during the years 1868 to 1877, inclusive. These Reports contain a good deal of matter anent the Cotton Worm, the Chinch Bug, the Rocky Mountain Locust, and other insects which the Commission has studied, and were published, as required by law, in the Annual Reports of said State Board of Agriculture for the years mentioned. That method of publication was always regretted by myself and by many others, inasmuch as the reports of the Board were generally volumes of such bulk as to delay publication and render mailing expensive. By virtue of the fact that they were distributed only to members of the State legislature and to State societies, access to them by persons outside the State of Missouri was extremely difficult; while the State printing and press-work were, as a rule, of a very unsatisfactory character. To avoid some of these difficulties it was my habit to have about 300 separate copies of the entomological portion printed on better paper, at my own expense, for distribution to correspondents both at home and abroad, and it is through these, principally, that the Reports have been accessible outside the State.

The demand for the Reports and the manner in which they have been used and commended by subsequent writers can but be gratifying to the author, who feels that whatever of commendation they deserve is due to the fact that they embody results of original investigation. They contain some matter that, with present light, he would expunge, and the earlier volumes, more particularly, contain imperfections which no one appreciates more fully than himself. Many of these are attributable to isolation from other working entomologists at the time, as well as to the almost absolute dearth of entomological works of reference in any of the libraries of Saint Louis.

The general plan of the Reports, which were addressed to the intelli-

gent cultivator of the soil rather than to the naturalist, is set forth in the following passage from the introduction to the first :

Fully aware that I write for those who, as a rule, are unversed in entomology, I have endeavored to treat of each insect with as little of the nomenclature of science as is consistent with clearness of expression. Yet, as much that is of scientific interest, such as descriptions of new species, must necessarily be inserted, I have had such descriptions printed in a type of smaller size than the text, so that it can be skipped if desirable, at the time of reading, and easily referred to for comparison, with specimens which one is desirous of naming. I have also endeavored to illustrate, as far as possible, the insects of which this report treats, believing that good illustration forms the basis of successful teaching in a science with which the general husbandman is not expected to be acquainted; for the eye conveys to the mind, in an instant, what the ear would fail to do in an hour. The practical man cares little to what genus or family an insect belongs, so long as he can tell whether it be friend or foe. He must become familiarized with the insects about him without having necessarily to overcome scientific detail and technicality.

I have made no effort at a systematic arrangement of the insects treated of. Indeed, that were useless for the purpose in view; but, in order that the reader may refer the more readily to any particular insect which interests him, I have separated them into three series—NOXIOUS, BENEFICIAL, and INNOCUOUS—and attached a very full index. For the benefit of those who are making a study of entomology, I have also given, with each species, the Order and Family to which it belongs, in parenthesis under each heading.

So far as possible, I have used a common name for each insect, knowing that the scientific name is remembered with greater difficulty, and is, consequently, distasteful to many. But as popular names are very loosely applied, and the same name often refers to different insects, in different localities, a great deal of confusion would ensue without the scientific name, which is, therefore, invariably added, for the most part, in parentheses, so that it may be skipped without interfering in any way with the sense of the text.

In order to add value to this general index, I have brought together tables of contents of the nine volumes and given corrections and some notes and additions. I have also reproduced the descriptions of new species, and added a list of descriptions of adolescent states, of descriptions of species not new, of illustrations by reports, of illustrations by classification, and of food-plants.

The Reports were independently paginated, and the separate copies were often distributed before the Agricultural Report was off the press. The date of publication and distribution is given for each in the tables of contents. The nomenclature of the Reports is retained in this Bulletin, the synonymy being indicated in the notes and additions and with the reproduced descriptions. The name of the author of the species and not of the genus was always given as authority, and in the later Reports I endeavored to indicate whether or not the insect was described under the generic name which it bears, by adding the authority without a comma when the specific name is coupled with the generic name under which it was first published — *e. g.*, *Phycita nebulo* Walsh — but placed it in parentheses when a different generic name was used than that under which the insect was first described — *e. g.*, *Acrobasis nebulo* (Walsh) — except where the whole name was already in parentheses when a comma

was used for the same purpose—*e. g.* (*Acrobasis nebulo*, Walsh). The same plan is adopted throughout this Bulletin.

It had always been my intention to publish a tenth volume and to end the decade with a review of, and general index to, the whole series. Indeed, an appropriation for the tenth year's work was made and the tenth report would have been duly issued had I not been called at the time to my present work for the General Government. This Bulletin is, in a measure, the fulfillment of that intention, and is issued in the hope that it will render the Reports more serviceable to the student of insect life and to those having to deal with insects injurious to agriculture.

My thanks are due to Messrs. E. A. Schwarz and W. H. Patton, agents of the Commission, for aid in its preparation.

C. V. R.

WASHINGTON, D. C., *March 1, 1881.*

TABLES OF CONTENTS.

Neither of the first five volumes contained a table of contents, the plan of giving such having been adopted with the sixth. Most of these tables are, therefore, prepared for this Bulletin, while those of the Sixth and Seventh Reports are amplified. Those of the last two volumes are reproduced as they were originally made.

REPORT I.

[Submitted December 2, 1868; published March, 1869.]

	Page.
Introductory	3
NOXIOUS INSECTS.	
The Bark-lice of the Apple-tree	7
Two species known to occur in the United States, 7 — Harris's Bark-louse not numerous enough to do material damage, 7.	
THE OYSTER-SHELL BARK-LOUSE	
Difference in the scales of the two species, 7 — Introduction of the Oyster-shell Bark-louse from Europe and its spread in the United States, 8 — Precautionary measures to prevent its introduction into Missouri, 8 — Its habits studied by different observers in 1867, 9 — Seasonal notes on the development of the insect, 10 — Only one annual brood in Missouri, 12 — Formation and nature of the scale, 12 — Rare occurrence of males, 14 — Difference of opinion among observers as to the mode of growth of the scale, 14 — Difficulty of explaining the spread of the insect from one tree to another, 15 — Its occurrence upon other kinds of trees, 15 — Natural enemies, 16 — Artificial remedies, 16 — Examination of young trees before planting, 16 — Washing with alkalies, etc., 17 — Scrubbing the branches with a stiff brush, 17 — Fumigating, 17 — Application of sheep-manure, 17 — Washes in general ineffective, 17 — The insect can most successfully be fought during three or four days of the year only, 18.	
The Periodical Cicada	18
Its singular life history, 18 — Seventeen and thirteen year races, 19 — The two races not distinct species, 19 — Two distinct forms occurring in both broods, 20 — Season of their appearance and disappearance, 22 — Natural history and transformations, 22 — Elevated chambers of the pupa, 22 — The larvæ frequently occurring at great depth in the ground, 24 — The operation of emerging from the pupa, 24 — Only the males are capable of singing, 24 — Trees in which the females deposit their eggs, 24 — Mode of oviposition, 24 — The newly hatched larva, 25 — The W on the wings of the Cicada, 25 — Enemies, 26 — Fungus infesting the imago, 26 — The sting of the Cicada, 26 — Wide-spread fear of the insect on ac-	

	Page.
The Periodical Cicada —Continued.	
count of its supposed stinging powers, 26—Explanations of the sting, 27—Injury caused by the insect, 29—by the larva, 29—by the imago, 29—Fruitless attempts to stop the injury, 30—Chronological table of all well-ascertained broods in the United States, 30—The insect will appear during the next 17 years somewhere in the United States every year except in 1873, 41—Number of broods that will appear in the next 17 years in the different States, 42.	
Apple-tree Borers	42
THE ROUND-HEADED APPLE-TREE BORER.....	42
It is more numerous in trees on high land than on low ground, 42—Extent of its injury, 43—Its larva, 43—Appearance of the imago, 43—The hole made by the young larva, 44—It remains nearly three years in the larva state, 44—Its pupa state, 44—Remedies, 45—Alkaline washes, 45—Killing the larva by hot water, 45—Cutting out the larva, 46.	
THE FLAT-HEADED APPLE-TREE BORER.....	46
Differences between it and the foregoing species, 46—Habits of the beetle, 47—Amount of injury caused by it, 47—Parasite attacking it, 47—Remedies, 47.	
The Peach Borer	47
Its nature, 47—Differences in the sexes, 48—Remedies, 48—The mounding system the best remedy, 48—Testimony as to the value of the mounding system, 48—Other remedies, 49.	
The Plum Curculio	50
Difference of opinion among authors on some points in its natural history, 50—Reasons for this difference of opinion, 51—Facts in its natural history, 52—It causes the spread of the peach-rot, 52—Fruit trees attacked and those not attacked by it, 53—It may hibernate as larva or pupa, but does generally as imago, 53—Mode of egg-laying, 54—It has one annual brood, 55—Walsh's experiments to show that it is two-brooded, 55—Natural remedies, 56—No parasites known to infest it, 56—Enemies, 57; The Pennsylvania Soldier-beetle, and its larva, 57; Lacewing-larva, 57; The Subangular Ground-beetle 58; Ground-beetle larva, probably of the Pennsylvania Ground-beetle, 59—Hogs as Curculio destroyers, 59—Artificial remedies, 60—Jarring the trees the most effectual method, 60—Dr. Hull's Curculio catcher 60—Lessons for the fruit-grower from the account of the Curculio, 62.	
The Codling Moth or Apple Worm	62
It is common wherever apples are grown, 62—Description of the insect in its different states, 63—Its life-history, 63—Other fruits attacked by it, 64—Remedies, 65—Picking up the fallen fruit, 65—Entrapping the worms the best remedy, 66—Trimble's hay band system and how to apply it, 66—Attracting the moth by fires, 67.	
Cut-worms	67
The natural history of twelve distinct species, 67—Definition of the term "Cut-worm", 67—Habits of Cut-worms, 67—Their natural history briefly given, 68—Difficulty of breeding them in captivity, 69—Climbing Cut-worms, 69—Injury done by them to orchards, 69—Fruit trees and shrubs they attack, 70—They attack large trees, 71.	
THE VARIEGATED CUT-WORM.....	72
The full-grown larva, 72—The eggs, 72—Habits of the larva, 72—Cut-worm moths deposit their eggs on the leaves and not on the ground, 73—The imago, 73—Description of the insect as larva, pupa, and imago, 74.	

	Page.
Cut-worms—Continued.	
THE DARK-SIDED CUT-WORM.....	74
General characters of the larva, 74—Habits of, and injury done by it, 75—Description of the imago, 75; of the larva and chrysalis, 76.	
THE CLIMBING CUT-WORM.....	76
Injury done by the larva, 77—General characters of the larva, 77; of the moth, 78—Description of the larva, 78; of the imago, 78.	
THE W-MARKED CUT-WORM.....	79
General characters of the larva, 79—Plants it attacks, 79—Characters of the moth, 79—Description of the larva and chrysalis, 79.	
THE GREASY CUT-WORM.....	80
The larva very variable in coloration, 80—Its injury to tomato and tobacco plants, 80—General characters of the moth, 80—Description of larva, chrysalis, and imago, 81.	
THE WESTERN STRIPED CUT-WORM.....	81
Resemblance of its larva to that of the Corn Rustic, 81—General characters of the worm and moth, 82—Description of the larva, 82.	
THE DINGY CUT-WORM.....	82
Difference between it and the foregoing species, 82—General characters of pupa and imago, 82—At least three species of our Cut Worms are difficult to distinguish, 83—Description of larva, chrysalis, and imago, 83.	
THE GLASSY CUT-WORM.....	83
Habits and general characteristics of the larva, 83—Characteristics of the moth, 84—Description of larva and chrysalis, 84.	
THE SPECKLED CUT-WORM.....	84
Characteristics and habits of the insect, 84—Description of larva, chrysalis, and imago, 85.	
THE SMALL WHITE BRISTLY CUT-WORM.....	86
Habits of the worm, 86—Characteristics of the moth, 86—Description of larva, chrysalis, and imago, 86.	
OTHER CUT-WORMS.....	87
Fitch's account of the Corn Cut-worm and the Yellow-headed Cut-worm, 87.	
THE WHEAT CUT-WORM.....	87
Injury caused by it, 87—Description of the larva, 88.	
REMEDIES AGAINST CUT-WORMS.....	89
Natural enemies, 89; <i>Microgaster militaris</i> , 89; <i>Panicus geminatus</i> , 89; The Spined Soldier-bug, 89; The Cut-worm Lion, 89—Other enemies, 90—Artificial remedies for climbing cut-worms, 90; for common field cut-worms, 91.	
Insects infesting the Potato.....	91
General remarks, 91—Number of species affecting the Potato, 92.	
THE STALK-BORER.....	92
Habits of the larva and imago, 92—Remedy, 93.	
THE POTATO STALK-WEEVIL.....	93
Its geographical distribution, 93—Its habits, 93—Remedy, 95.	
THE POTATO- OR TOMATO-WORM.....	95
It cannot sting with its horn, 95—Its chrysalis, 95—How the imago differs from the Tobacco-worm Moth, 95—Remedies and parasites, 96.	
BLISTER-BEETLES.....	97
The Striped Blister-beetle, 96—The Ash-gray Blister-beetle, 97—The Black-rat Blister-beetle, 98—The Black Blister-beetle, 98—The Marked Blister-beetle, 98—Synonymical remarks, 98—Remedies for Blister-beetles, 99.	

	Page.
Insects infesting the Potato—Continued.	
THE THREE-LINED LEAF-BEETLE	99
Merdigerous habit of the larva, 99—It has two annual broods, 100— Other notes on the habits of the insect, 100.	
THE CUCUMBER FLEA-BEETLE	101
THE COLORADO POTATO-BEETLE	101
Its past history and future progress, 101—Its native home, 101—Its gradual spread eastward, 102—Its confusion with the Bogus Colorado Potato-beetle, 103—How the two species differ in habits, 104; in their larval states, 104; in the egg-state, 105—Description of the larva of <i>Doryphora juncta</i> , 106—Differences in the imagos of the two species, 106 —Habits of the Colorado Potato-beetle, 107—When it appears and dis- appears, 107—Number of eggs laid by each female, 107—Food-plants, 107—Singular fact that <i>D. juncta</i> has not acquired the habit of attack- ing the Potato, 108—Natural remedies, 109—Complicated economy of nature, 109—Decrease in the number of Potato-beetles on account of increase in the number of parasites, 109—The Colorado Potato-beetle parasite, 111—Its general character and habits, 111—Description of <i>Lydella doryphora</i> , 111—Ladybirds and their larvæ, 112—The Spined Soldier-bug, 113—The Common Squash-bug erroneously considered an enemy of the Potato-beetle, 113—The Bordered Soldier-bug, 114—The Many Banded Robber, 114—The Rapacious Soldier-bug, 114—The Virginia Tiger-beetle, 115—The Fiery Ground-beetle, 115—Blister- beetles, 115—The larvæ not touched by fowl, 115—Artificial remedies, 116—Ineffectiveness of mixtures tried, 116—Killing the beetle early in spring, 116—Pincers for crushing the insect, 116—Benson's machine, 116—Proper choice of varieties of potatoes, 117—The pest will over- run the Eastern States, 117—Carelessness in transmitting specimens of the beetle, 117.	
The Apple-root Plant-louse	118
Three distinct kinds of rots affecting the roots of Apple-trees, 118—The Root-louse the cause of one of these rots, 118—The cause of the other rots still hidden, 119—The Root-louse especially injurious in southerly latitudes, 119—It occurs also on other parts of the tree besides the root, 120—Description of the winged louse, 120—Fitch's description of the winged form refers to another species, 120—The Root-louse belongs to the genus <i>Eriosoma</i> , 121—Natural enemies, 121; Chalcis-fly, 121; The Root-louse Syphus-fly, 121; <i>Scymnus cervicalis</i> , 122—Artificial remedies, 123.	
The Woolly Elm-tree Louse	123
Its general appearance and habits, 123—Description of the winged form, 124,	
Insects Injurious to the Grape-vine	124
THE NEW GRAPE-ROOT BORER	124
Reports on the damage caused by it, 124—Description of the larva, 126— It belongs probably to the Cylindrical Orthosoma, 126—Former ac- counts of the natural history of this beetle, 127—Its injury known for several years, 127—Remedies, 128.	
THE GRAPE CURCULIO	128
Nature of the damage done by it, 128—Its larva, 128—The perfect beetle, 129—No injury done by it in 1868, 129.	
THE GRAPE-SEED CURCULIO	129
General appearance of the maggot, 129—Mr. Saunders' account of the damage done by it, 130.	

	Page.
Insects Injurious to the Grape-vine—Continued.	
THE GRAPE-CANE GALL-CURCULIO.....	131
The Gall caused by it, 131 — The larva, 131 — Its transformation, 131 — Description of the beetle, 132 — Differences between it and a closely allied species, 132 — The Gall caused by the punctures of the female beetle, 132 — Remedy, 132.	
THE GRAPE-VINE FIDIA.....	132
It is very injurious in Missouri, 132 — Habits of the beetle, 132 — Remedies, 133.	
THE GRAPE FRUIT-WORM.....	133
Amount and extent of the injury caused by it, 133 — Characteristics of the larva, 134 — Transformations, 134 — Description of larva, chrysalis and imago, 135 — Remedies, 135.	
THE EIGHT-SPOTTED FORESTER.....	136
Characteristics of the larva, 136 — It is not numerous enough to cause serious injury, 136 — Other caterpillars resembling it, 136.	
THE GRAPE-VINE PLUME.....	137
Work of the larva, 137 — Its habits and characteristics, 137 — The moth, 137 — Remedy, 138.	
THE SNOWY TREE-CRICKET.....	138
Characteristics of the insects, 138 — It is injurious, 133 — Nature of the injury caused by it, 138 — Remedy, 139.	
The Raspberry Geometer.....	139
Habits of the larva, 139 — Parasite attacking it, 139 — Characteristics of the moth, 139 — Description of the larva, 139; of the imago, 140.	
The Gooseberry Fruit-worm.....	140
Accounts of the injury caused by it, 140 — Habits of the worm, 140 — The moth, 141 — Remedies, 141 — Description of larva, chrysalis, and imago, 141.	
The Strawberry Leaf-roller.....	142
Extent and nature of the damage caused by it, 142 — Habits of the insect, 142 — Accounts of its injury in Indiana and Illinois, 142 — Remedy, 143 — Description of the imago and larva, 143.	
The White-marked Tussock-moth.....	144
The egg-mass, 144 — The larva and larval changes, 144 — The full-grown larva, 145 — Habits of the larva, 145 — Mode of casting off the larval skin, 145 — The cocoon, 146 — The imago, 146 — Two annual broods, 146 — Food-plants, 146 — Remedies, 147.	
The Bag-worm, <i>alias</i> Basket-worm, <i>alias</i> Drop-worm.....	147
Its geographical distribution, 148 — Injury caused by it, 148 — The egg, 148 — The larva and its growth, 148 — Habits of the larva, 149 — The chrysalis, 149 — The sex distinguishable in the chrysalis state, 149 — The imago, 149 — Food-plants, 150 — Parasites, 150; <i>Cryptus inquisitor</i> , 150; <i>Hemiteles thyridopterygis</i> , n. sp., 150 — Remedies, 151.	
The Ailanthus-worm.....	151
Injury done to the Ailanthus tree, 151 — Habits of the larva, 151 — The chrysalis, 151 — The imago, 152 — Geographical distribution, 152 — Remedy, 152 — Description of larva and chrysalis, 152; of the imago, 153.	
The Walnut Tortrix.....	153
Habits of the larva, 153 — General appearance of the moth, 153 — Phytophagic form of the insect on Snowberry, 153 — Description of larva, chrysalis, and imago, 154; of the variety <i>symphoricarpi</i> , 154.	

	Page.
The Seed-corn Maggot	154
Accounts of damage caused by it, 154 — The maggot, 155 — Transformation 155 — Description of the imago, 155 — Remedy, 155 — Habits of <i>Anthomyia</i> larvæ, 156.	
The White Grub	156
Account of the damage caused by it, 156 — Injury done by the perfect insect, 157 — <i>Résumé</i> of its life-history, 157 — Remedies, 157 — Regularity in the appearance of the beetle, 158 — Accounts of the fungus infesting the White Grub, 158.	
The American Meromyza	159
Nature of the damage caused by it, 159 — Characteristics of larva, chrysalis and imago, 160 — European Diptera with similar habits, 160 — Remedies, 161.	
The Sheep Bot-fly or Head-maggot	161
The insect in its different states, 161 — Its larva, 162 — Pupa, 162 — Characteristics of the imago, 162 — Fatal results of the presence of the maggot in the head of the sheep, 163 — Rabbits attacked by gad-fly, 164 — Testimony regarding the viviparous habits of the Bot-fly, 164 — Remedies, 165.	
Insect enemies of the Honey-bee	166
THE BEE-MOTH OR WAX-WORM	166
General appearance of the moth, 166 — There are no moth-proof bee hives, 166 — Habits of the worm, 167 — How its presence in the hive may be recognized, 167 — Prevention and remedy, 167.	
THE BEE-KILLER	168
It is an Asilid fly, 168 — Mr. Thompson's account of the fly, 168 — How it captures and kills bees, 168 — No remedy known, 168.	

BENEFICIAL INSECTS.

The Rear-horse, <i>alias</i> Camel-cricket, <i>alias</i> Devil's Riding-horse	169
Its food, 169 — How it grasps its prey, 169 — Difference in the sexes, 170 — The larva, 170 — The egg-mass, 170 — The mode of egg-laying, 170 — Voracious disposition of the Mantis, 171 — Its beneficial influence, 171 — Tachina-parasite of the Mantis, 171.	

INNOXIOUS INSECTS.

The Solidago Gall-moth	173
Gall caused by <i>Trypeta solidaginis</i> , 173 — Gall produced by the Solidago Gall-moth, 173 — Its natural history, 173 — Provision of the larva for its protection within the gall, 174 — Previous account of the gall, 174 — Gall caused by <i>Cochylis hilarana</i> on <i>Artemisia campestris</i> , 175 — Description of the Solidago Gall-moth as larva, chrysalis, and imago, 175 — Parasites attacking it, 175; the Inflating Chalcis, 176; <i>Eurytoma botteri</i> , n. sp., 176; <i>Hemiteles</i> (?) <i>cressonii</i> , n. sp., 177; <i>Microgaster gelechiæ</i> n. sp., 177; other parasites, 178 — <i>Oberca</i> larvæ intruding the gall, 178.	
The Knotweed Geometer	179
Its natural history, 179 — Description of larva and chrysalis, 179.	
The Thistle Plume	180
Work of its larva on thistle-heads, 180 — Description of the larva, chrysalis, and imago, 180.	

REPORT II.

[Submitted December 2, 1869; published March, 1870.]

Preface	3
---------------	---

NOXIOUS INSECTS.

Report of the Committee on Entomology of the State Horticultural Society	5
--	---

Noxious insects less injurious in Missouri in 1869 than usual, 5 — The Army Worm and the Grain Plant-louse considerably injurious in Missouri in 1869, 5 — The Chinch Bug and the Codling Moth less injurious, 6 — A species of *Thrips* destroying great numbers of the Curculio, 6 — Eggs of the Apple-tree Plant-louse destroyed by insect foes and birds, 6 — According to Dr. Hull the "scab" in apples is caused by the Apple-tree Plant-louse, 7 — The Pickle Worm doing great damage during 1869, 7 — Importance of preventing the introduction of injurious insects, 7 — Cultivation causes insects to multiply unduly, 8 — More attention paid in Europe to injurious insects than in this country, 8.

IMPORTED INSECTS AND NATIVE AMERICAN INSECTS

The imported Currant-worm much more injurious than the native, 8 — Other instances showing the greater destructiveness of imported insect enemies than of their native representatives, 9 — Almost all our worst insect pests and pernicious weeds have been introduced from Europe, 10 — Few American insects and plants have become naturalized in Europe, 11 — The American fauna and flora not so highly improved and developed as in Europe, 12 — Australian fauna still more "old-fashioned" than America, 12 — The parasites of injurious insects are not imported with the insects themselves, 13 — Government aid should be solicited to exterminate recently imported injurious insects, 13 — But little attention given so far by our Government to assist the study of economic Entomology, 14 — Danger of introducing the Oyster-shell Bark-louse into Missouri, 15 — Immunity of the Pacific States from many of our fruit insects, 15.

The Chinch Bug	15
----------------------	----

It is the most injurious of all insects infesting grain, 16 — Its past history, 17; it was known in South Carolina in Revolutionary times, 17; it was injurious in Missouri as early as 1854, 17; noticed in Illinois in 1840, 17; it was very injurious in Missouri in 1868, 17; but hardly noticed in 1869, 17 — Probable reason why it was not noticed in Missouri in former times, 18 — Why it is not injurious in Massachusetts and New York, 18 — Its natural history, 18 — The pupa state in the different insect Orders, 18 — Time required for different insects to complete the cycle of development, 19 — The Chinch Bug is two-brooded in Missouri, 19 — Its winter quarters, 20 — Its rapid multiplication, 20 — Dr. Shimer's account of its nuptial flights, 21 — It deposits the eggs underground on the roots of the plant, 21 — The egg, 22 — Dimorphous forms of the Chinch Bug, 22 — Its destructive powers, 22 — Account of its appearance in immense numbers, 23 — Heading off the marching Bugs by a barrier of pine boards, 23 — Heavy rains destructive to the Chinch Bug, 24 — Moisture injurious to the egg, 24 — The Chinch Bug is always worse in a dry season than in a wet one, 24 — Dr. Shimer's theory on epidemic disease affecting the Chinch Bug, 25 — Cannibal foes of the Chinch Bug, 25; several species of Ladybirds, 25; the Weeping Lacewing, 26; How the

The Chinch Bug—Continued.

Lacewing larva seizes its prey, 26; The Insidious Flower-bug, 27; the Common Quail, 28—Amount of damage done by the Chinch-bug, 28—Remedies, 28—Burning in winter the old corn-stalks and other dead stuff on and near the fields, 29—Mixing winter rye among spring wheat, 29—Intercepting the marching Bugs by fence-boards, 29—Sowing gas-line, 30—Other remedies, 30—Bogus Chinch Bugs, 31—Several species of Heteroptera confounded with the true Chinch Bug, 31—The smell emitted by the Half-winged Bugs, 32—The Insidious Flower-bug, 32—The Ash-gray Leaf-bug and its injury to grape-vines, 33—The Flea-like Negro-bug, 33; injury caused by it to raspberry, strawberry, and garden flowers, 34—Two other species of Negro-bug, 35—Recapitulation of the natural history of the Chinch Bug, 36.

The Army Worm	37
Four distinct caterpillars designated as Army Worms in this country, 37.	
THE TENT-CATERPILLAR OF THE FOREST	37
It cannot properly be called an Army Worm, 37.	
THE COTTON WORM	37
Historical data on the injury caused by it, 38—The egg, 38—The worm and its habits, 39—Mr. Lyman's incorrect account of its development, 39—The moth and its habits, 40—Its hibernation, 40—Remedies, 41.	
THE SOUTHERN GRASS-WORM	41
It resembles in habits the veritable Army Worm, 41.	
THE TRUE ARMY WORM	41
Its past history, 41—Rev. Powers' account of its invasion in the New England States in 1770, 42—Accounts of later invasions previous to 1861, 43—Years of its appearance in Illinois, 43—The invasion of the year 1861, 44—Its appearance in Missouri in 1869, 44—Its sudden appearance and disappearance, 45—Reason for the apparently sudden appearance, 45—Army Worm years are wet with the preceding year dry, 46—Reason for the increase and decrease of the number of worms, 46—Its natural history, 47—Previous accounts of its natural history, 47—When the eggs are laid, 47—Where they are laid, 48—Misdirected instinct in insects and birds, 48—Exceptions to the normal habit of the Worm, 48—Color of the Worm, 49—The chrysalis and imago, 49—Parasites, 50; The Red-tailed Tachina-fly, 50; Its beneficial work, 50; It infests also other insects, 50; Walsh's description of the fly, 51; It has been re-described as <i>Erorista OstenSackenii</i> , 51; The Yellow-tailed Tachina-fly, 51; Description of the fly, 51; The Glassy Mesochorus, 52; The Diminished Pezomachus, 52; The Military Microgaster, 52; The Purged Ophion, 53; The Army-Worm Ichneumon-fly, 53—Habits of the Army Worm and suggestions for its destruction, 53—Burning grass meadows in winter or early spring, 54—Plowing late in the fall, 54—The marching of the Worms, 54—Plants they prefer, 54—They become beneficial by devouring the chess in the fields, 55—Ditching, 55—Description of the insect as larva and imago, 56.	
Insects infesting the Sweet-potato	56
TORTOISE-BEETLES	57
The Clubbed Tortoise-beetle affects the Irish Potato, 56—Its general appearance, 57—Characteristics of Tortoise-beetles, 57—Merdigerous habits of Tortoise-beetles and others of the same family, 58—General appearance of the larvæ, 58—Their dung parasol, 59—Larval molts, 59—Egg of Tortoise-beetles, 60—The chrysalis, 60—Habits of and injury done by the beetles, 60—Remedies, 61.	

Insects infesting the Sweet-potato—Continued.

- THE TWO-STRIPED SWEET-POTATO BEETLE** 16
 It seems to be confined to that plant, 61 — The larva and the use of its fork, 61 — Its pupa and imago, 61.

- THE GOLDEN TORTOISE-BEETLE** 62
 Food-plants and characteristics of the larva, 62 — Brilliant color of the beetle, 62.

- THE PALE-THIGHED TORTOISE-BEETLE** 62
 It is hardly distinguished from the foregoing species, 62.

- THE MOTTLED TORTOISE-BEETLE** 63
 Characteristics of the beetle, 63 — of the larva, 63.

- THE BLACK-LEGGED TORTOISE-BEETLE** 63
 Characteristics of imago and larva, 63.

The Pickle Worm 64**OTHER INSECTS INFESTING CUCURBITACEOUS VINES** 64

- The Squash Borer, 64 — It seems to be confined to the Eastern States, 64 — The Striped Cucumber-beetle, 64 — Injury done by the beetle, 64; by the larva, 65 — The larva and pupa, 65 — Number of annual generations, 65 — Remedies, 66 — Extent of the injury caused by it, 66 — The 12-Spotted Diabrotica, 66.

THE PICKLE WORM 67

- Characteristics and description of the worm, 67 — Its habits, 67 — Characteristics of the moth, 68 — Accounts of injury done by the worm in Missouri and Illinois, 69; in other portions of the country, 70 — It was not known before as injurious, 70 — Remedy, 70.

Insects injurious to the Grape-vine 71**THE HOG CATERPILLAR OF THE VINE** 71

- The egg, 71 — Characteristics of the larva, 71 — Its habits when about to transform, 72 — The chrysalis and imago, 72 — It is one-brooded North and two-brooded further South, 72 — It is very injurious, 73 — The Microgaster parasite and its development, 73 — Habits of caterpillar infested with the parasite, 73.

THE ACHEMON SPHINX 74

- Appearance and habits of the larva, 74 — The chrysalis, 75 — The insect is single-brooded, 75 — The moth and its issuing from the pupa shell, 75 — No parasites known, 76.

THE SATELLITE SPHINX 76

- How to distinguish its larva from that of the foregoing species, 76 — Development of the larva, 76 — Variations in color of the larva, 77 — Its position when at rest, 77 — The moth, 78.

THE ABBOT SPHINX 78

- Its distribution, 78 — The larva varies much in color, 78 — The chrysalis and imago, 79.

THE BLUE CATERPILLARS OF THE VINE 79

- The Eight-spotted Forester, 80 — Larva previously mistaken for it, 80 — habits and characteristics of the larva, 80 — Harris's description of the larva, 81 — The moth, 81 — Mr. Andrews' account of its ravages, 81 — Remedies, 82.

- The Beautiful Wood Nymph, 83 — Characteristics of the moth, 83 — Close resemblance between the larva of this and the foregoing species, 83 — The differences pointed out, 83 — Development of the insect, 83.

- The Pearl Wood Nymph, 83 — It greatly resembles the Beautiful Wood Nymph, 83 — Its probable larva, 84 — Practical importance of distinguishing these closely allied species, 84.

	Page.
Insects injurious to the Grape-vine—Continued.	
THE AMERICAN PROCRISES	85
Work of its larva, 85—Description of full-grown larva, 86—The moth, 86—It is not very destructive, 86—Two annual broods of the insects, 86—Parasite of the American Procris, 87.	
THE NEW GRAPE-ROOT BORER	87
Correction of opinion formerly expressed, 87.	
The Broad-necked Prionus, 87—Duration of the larva state, 87—Its transformation, 88—It bores also in Apple roots, 88—Great damage done by the borer, 88—No good remedy known, 88.	
The Tile-horned Prionus, 89—How it differs from the foregoing, 89—Its occurrence on prairie land, 90—Small dimorphous male form, 90—The larva subsists also upon the roots of herbaceous plants, 90—Practical considerations, 91.	
THE GRAPE-SEED MAGGOT	92
The Grape-seed Curculio larva of the first report is that of a Hymenopterous insect, 92—The perfect insect is closely allied to the Joint-worm Fly, 92—Mr. Saunders' account and description of the imago, 93.	
The Canker Worm	94
The eggs, 94—The larva and larval changes, 95—Importance for the orchardists to recognize the true Canker Worm, 95—The Imported Elm leaf-beetle mistaken for it, 95—Description of the larva, 96—Its food-plants, 96—The chrysalis. 96—Only one annual brood in the latitude of Saint Louis, 97—The moth and its varieties, 97—It is less injurious in Missouri than in the Eastern States, 97—Remedies, 98—Classification of remedies proposed, 98—The trough and bandage systems, 99—Muriate of lime as remedy, 100—Jarring the tree, 101—Late fall plowing, 101—Summer plowing, 102—Efficiency of hogs, 102—Enemies, 102; Birds, mite and parasites, 102; Ground-beetles, 103; The Fraternal Potter-wasp, 103.	
Cabbage Worms	104
THE SOUTHERN CABBAGE BUTTERFLY	104
Its geographical range, 104—Injury caused by it in Missouri, 104—Description of the larva, 105—The chrysalis and imago, 105—Habits and other food-plants, 105.	
The Potherb Butterfly, 105—It is a Northern species, 105—It will very likely never occur in Missouri, 106—Geographical range of insects principally influenced by temperature, 106—Isentomic lines, 106—Southern insects found near Saint Louis, 106.	
The Imported Cabbage Butterfly, 106—Amount of damage caused by it in Canada, 107—Its spread westward, 107—It will undoubtedly spread to St. Louis, 107—The insect in Europe, 107—History of its introduction, 107—The insect in its different stages, 108—Its food, 108—Remedies, 109—Parasites, 109.	
THE CABBAGE PLUSIA	110
Characteristics and habits of the larva, 110—Its transformations, 111—Remedies, 111—Description of larva, chrysalis and imago, 111—A similar worm occurring on thistles, 112.	
THE ZEBRA CATERPILLAR	112
Habits and characteristics of the larva, 112—The chrysalis and the moth, 113—Two annual broods, 113—Food-plants, 113.	
The Tarnished Plant-bug	113
Injury caused by it to various trees and plants, 114—It is a very variable species, 114—Its development, 114—No effective remedy known, 115—Preventive measures, 115.	

	Page.
The Philenor Swallow-tail	116
Its food-plant, 116 — Damage done by it, 116 — Characteristics and development of the larva, 116 — Description of the larva, 117 — The pupa, 117 — The imago, 117 — Prevention, 118.	
The Cottonwood Dagger	119
General appearance of the larva, 119 — Two annual broods, 119 — Chrysalis and moth, 119 — Larvæ of other species belonging to the genus <i>Acronycta</i> , 119 — Parasites, 120 — Description of larva and imago, 120 — Characters and habits of other species of the same genus, 121.	
The Missouri Bee-killer	121
The true scientific name of the Nebraska Bee-killer, 121 — Wing-veins of the genera <i>Asilus</i> , <i>Promachus</i> and <i>Eraz</i> , 122 — Description of the Missouri Bee-killer, 122 — How to destroy the flies, 123 — Habits and life-history of <i>Asilus</i> -flies, 123 — Description of larva and pupa of <i>Eraz Bastardi</i> (?), 124 — Synonymical notes on the imago, 124.	

INNOXIOUS INSECTS.

The Goat-weed Butterfly	125
Its geographical distribution and position in classification, 125 — Its food-plant, 125 — Habits of the larva, 126 — Larval changes, 126 — Conformity in the color of the larva with that of the leaves, 127 — Description of the full-grown larva, 127 — Transformation of the larva to chrysalis, 127 — The two sexes of the imago, 127 — Hibernation, 128.	
The Black Breeze-fly	128
Breeze-flies beneficial in the larva state, 128 — Tormenting power of Breeze-flies, 128 — Their mode of flight, 129 — Our knowledge of their larval character and habits, 129 — General characters of the larva of the Black Breeze-fly, 129 — It is semi-aquatic, 129 — Walsh's description of the larva, 130 — Habits and food of the larva, 130 — Its transformations, 131 — Description of the pupa, 131 — Probable habits of Breeze-fly larvæ on the Western prairies, 132.	
Galls made by Moths	132
THE FALSE INDIGO GALL-MOTH	132
The gall and its structure, 132 — General appearance of the larva and the moth, 133 — Description of larva and imago, 133.	
THE MIS-NAMED GALL-MOTH	134
Is it a true gall-maker or an inquiline?, 134 — Walsh's description of the larva, 134 — Description of the imago, 134 — Generic characters, 134 — Reasons why the insect is an intruder and not a gall-maker, 134 — Enumeration of the known gall-making moths, 135 — How the gall is formed, 135.	

REPORT III.

[Submitted December 2, 1870; published April, 1871.]

Preface	3
----------------------	---

NOXIOUS INSECTS.

Snout-beetles	5
The whole vegetable kingdom and every part of each plant serve as food for insects, 5 — Enumeration of insects affecting the different parts of the Apple-tree, 5 — Other food-habits of insects, 7 — Vast extent of the science of entomology, 8 — Beauty and simplicity of classification in entomology, 8 — Each family distinguished by its general appearance, 8 — Unity of habits in each family, 9 — Distinguishing characters of Snout-beetles, 9 — Their larvæ, 10 — They are among the most injurious beetles, 10 — Injurious Snout-beetles in Europe, 11.	

Snout-beetles—Continued.

	Page.
THE COMMON PLUM CURCULIO	11
It is single-brooded, 11 — Experiments to prove this fact, 12 — It hibernates as beetle, 13 — Form of the egg, 13 — Feeding habits of the beetle, 13 — Creaking noise produced by it, 14 — Stridulation in other insects, 14 — It is nocturnal rather than diurnal, 14 — Habits of the beetle at night, 14 — Remedies, 15 — The Ransom Chip-trap process, 15; explanation of the process, 15; it is not so successful as anticipated, 15; it is not a new discovery, 16; number of Curculios caught by it, 16; its success dependent on the character of the soil, 17; directions for using the process, 17; more experiments needed, 17 — Offering premiums for collecting specimens, 17 — Absurdity of the application of Paris Green for the Curculio, 18 — Jarring by machinery, 18 — The Hull Curculio-catcher defective in several respects, 18 — The Ward Curculio-catcher, 20; how it could be improved, 20; rules for using the machine, 21 — Curculio-catcher invented by Claxton & Stevens, 22 — Hooten's Curculio-catcher, 22; its advantages and mode of operation, 24 — Two true parasites of the Plum Curculio, 24 — The <i>Sigalphus</i> Curculio parasite, 24; Fitch's account of it, 25; Walsh's doubt about its being parasitic on the Curculio, 25; experiments and observations proving that it is a parasite of the Curculio, 25; its development and frequent occurrence around St. Louis, 25; it attacks also other soft-bodied larvæ, 26; points in its natural history, 26; its position in the system, 27; description of the imago, larva, pupa, cocoon and of the var. <i>rufus</i> , 27 — The Porizon Curculio parasite, 28; how it differs from the foregoing, 28; description of the imago, 28 — Importance of the work of these parasites of the Curculio, 29 — Artificial propagation and distribution of parasites, 29.	
THE APPLE CURCULIO	29
How it differs from the Plum Curculio, 30 — Its natural history, 30 — Food-plants, 30 — The punctures it drills into the fruit, 31 — The egg, 31 — The larva and its habits, 31 — The larva transforms within the fruit, 32 — Amount of damage it does, 33 — How its work in the fruit can be distinguished from that of other insects, 33 — It is very injurious in Southern Illinois and parts of Missouri, 33 — It is less injurious to apples than the Plum Curculio, 33 — Injury done by it to pears, 33 — The rot in apples principally produced by it and by the Plum Curculio, 34 — Season of its appearance, 34 — Remedies and preventive measures, 34 — Description of larva and pupa, 35.	
THE QUINCE CURCULIO	35
Its food-plants, 35 — It is very injurious to the quince in the East, 36 — Dr. Trimble's account of the damage done by it, 36 — How the beetle differs from the two preceding Curculios, 36 — Its transformations and habits, 37 — Its puncture on the fruit, 37 — It hibernates in the larva state, 37 — Its larva mistaken by Dr. Fitch for that of the Plum Curculio, 38 — The imago state lasts only two months, 38 — It does not attack the Apple, 38 — Remedies, 38 — Description of the larva and pupa, 39.	
THE PLUM-GOUGER	39
How it differs from the preceding species, 39 — Injury caused by it, 39 — Food-plants, 40 — It is often mistaken for the Plum Curculio, 40 — Season of its appearance, 40 — Holes bored by it in the fruit, 41 — The larva lives within the kernel of the fruit, 41 — Remedies, 41.	
THE STRAWBERRY CROWN-BORER	42
Distribution of the insect, 42 — Injury done by it, 42 — Habits and characters of the larva, 43 — Habits of the beetle, 43 — Remedies, 43 — Parasite, 44 — How the larva differs from that of the Grape-vine <i>Colaspis</i> , 44 — Description of the imago and larva, 44.	

	Page.
Snout-beetles—Continued.	
THE PEA-WEEVIL	44
Insect enemies of the garden pea, 44 — Characters of the <i>Bruchides</i> , 45 — Habits of other species of <i>Bruchida</i> , 45 — Frequent occurrence of its larva in green peas, 45 — Characteristics of the beetle, 46 — It is in all probability an indigenous North American insect, 46 — The beetle does not sting the peas, 46 — The eggs are fastened by the female beetle on the outside of the pod, 47 — The larva and its habits, 47 — Its transformations, 47 — Remedies and preventives, 48 — Examination of peas intended for seed, 48 — Concerted action necessary to exterminate the insect, 48 — Mr. Saunders' account of the occurrence of the Pea-weevil in Canada, 49 — Other preventive measures, 49 — Birds destroying the insect, 50.	
THE GRAIN BRUCHUS	50
Its introduction from Europe, 50 — How it differs from the Pea-weevil, 50 — Curtis' account of its habits in Europe, 51.	
THE AMERICAN BEAN-WEEVIL	52
Food-plants, 52 — Its geographical distribution, 52 — Accounts of damage done by it in New York and Pennsylvania, 52 — It has only lately become injurious, 53 — Habits of the larva and beetle, 54 — The proper nomenclature of the species, 54 — Description of the imago, 55 — Its differences from allied species, 54 — Note on descriptions based upon individual variations, 56.	
THE NEW YORK WEEVIL	57
Damage caused by it to fruit trees, 57 — Former descriptions of the insect, 57 — Its breeding habits, 57 — The Pear Blight not caused by the beetle, 58.	
THE IMBRICATED SNOOT-BEETLE	58
Injury done by it to vegetation, 58 — Its natural history still unknown, 58 — General appearance of the beetle, 58.	
THE CORN SPHENOPHORUS	59
Damage caused by it to corn plants, 59 — Characteristics of the beetle, 59 — Its larval history still unknown, 59 — Probable habits of the larva, 59 — Walsh's description of the imago, 59.	
THE COCKLEBUR SPHENOPHORUS	60
It is not injurious, 60 — Coloration of the beetle and its probable identity with <i>S. 13-punctatus</i> , 60 — The larva, 60 — Enumeration of other injurious Snout-beetles, 60.	
Insects injurious to the Grape-vine	61
THE GRAPE LEAF-FOLDER	61
Its geographical distribution, 61 — Generic characters, 61 — Characters of the moth, 61 — Sexual differences, 62 — Habits of the larva, 62 — Remedy and prevention, 62 — Natural enemies, 62 — Description of the larva, 62.	
THE GRAPE-VINE EPIMENIS	63
Its larva formerly mistaken for that of the Pearl Wood Nymph, 63 — Characters of the moth and sexual differences, 63 — Habits of the larva when about to transform, 64 — Its grape-vine feeding habits formerly unknown, 64 — Description of the larva, 64; of the chrysalis, 65.	
THE GRAPE-VINE PLUME	65
Work of its larva and of that of the Grape-vine Epimenis, 65 — Both larvae rather beneficial when not too numerous, 65 — Characters of the larva, 66 — Peculiar form of the pupa, 66 — Protective mimicry of the pupa, 67 — Habits and appearance of the moth, 67 — Is it single or double-brooded, 67.	

	Page.
Insects injurious to the Grape-vine—Continued.	
THE COMMON YELLOW BEAR.....	68
How the young larvæ differ from the mature larva of the Grape-vine Plume, 68— Food-plants, 68— Color variations in the larvæ, 69— The chrysa- lis, 69— The imago, 69— Parasites, 69— Remedy, 69.	
THE SMEARED DAGGER	70
The larva is polyphagous, 70— Characters of larva, pupa, and imago, 70— Remedy, 70— Parasites, 71— Description of imago and larva, 71; of the pupa, 72.	
THE PYRAMIDAL GRAPE-VINE WORM.....	72
Distinguishing characters of the Worm, 72— Its food-plants, 72— Its trans- formations, 72— It is single or double-brooded according to latitude, 73— Its closely allied congener in Europe, 73— Remedies, 73— Descrip- tion of the larva, 73; of pupa and imago, 74— How it differs from <i>Amphipyra pyramidea</i> , 74— Description of larva and imago of the Spat- tered Copper Underwing, 75.	
THE GRAPE-ROOT BORER	75
Its distribution, 75— Distinguishing characters of the larva, 76— Its transformation, 76— Characters of the moth, 76— Description of the imago and its sexual differences, 76— Work of the larva on grape- roots, 77— Remedies, 77.	
THE SPOTTED PELIDNOTA	77
It is usually not injurious, 77— The larva and its habits, 78— The beetle, 78— Description of the larva, 78.	
THE GRAPE-VINE FLEA-BEETLE	79
It is well-known to the grape-grower in Missouri, 79— Its distribu- tion and food-plants, 80— Hibernation, 80— Damage done by the beetle in spring, 80— The eggs, 80— Damage caused by the larvæ, 80; their transformation, 80— Remedies, 80— Description of the larva and pupa, 81.	
THE GRAPE-VINE COLASPIS	81
Fitch's account of the insect, 82— Varieties of the beetle, 82— The larva in all probability attacks sometimes that of the Leaf-folder, 82— It lives on the roots of the Strawberry, 82— Larva of the European <i>Colaspis</i> <i>barbara</i> , 82— Difference in habits of larvæ of allied species, 83— Singu- lar characters of the larva of the Grape-vine Colaspis, 83— Work of the larva on Strawberry roots, 83— Remedy, 84— Description of the larva, 84.	
THE GRAPE-LEAF GALL-LOUSE.....	84
Its life-history not yet fully studied, 84— Previous accounts of the insect by Fitch, Shimer, and Walsh, 85— The root disease in France, 85— The <i>Phylloxera vastatrix</i> recognized as the cause of this disease, 85— Identity of the gall-louse with the root-inhabiting insect, 86— The American and European insects are identical, 86— Remedies tried in France, 86— The disease directly caused by the Phylloxera, 87— Injury done by the Phyl- loxera in Missouri, 87— Forming of the gall, 87— Propagation of the lice and multiplication of the galls, 88— The gall-lice descend in the latter part of the season to the roots, 88— Change of the insect after passing from the leaves to the root, 88— Questions still to be settled in the life-history of the Phylloxera, 83— Rare occurrence of the winged form, 89— The insect can be transported from one place to another on roots, 89— It hibernates on the roots, 89— Grape-vines that should be planted, 89— Number of indigenous species of the Grape-vine, 90— Grape-vines which are most seriously infested with the Grape leaf- louse, 90— Danger in planting the Clinton among other grapes, 91— In-	

Insects injurious to the Grape-vine—Continued.**THE GRAPE-LEAF GALL-LOUSE.**

sects acquiring different food-habits as illustrated in the Apple-maggot and the Pine-leaf Scale, 92—The different forms of the Grape leaf-louse, 93—Discussion on the proper place of the insect in the classification, 93—On Dr. Shimer's proposed new families *Dactylosphaeridae* and *Lepidosaphidae*, 93—Objections to Fitch's specific name *vitifoliae*, 95—Identity of the European with the American insect, 95—The Apple-root louse is identical with the Woolly Aphis, 95—The Gall-inhabiting form of the Phylloxera identical with the root-inhabiting type, 96—Characters of the genus *Phylloxera* and its place in the system, 96.

The Colorado Potato-beetle again	97
Its onward march, 97—It invades the Dominion of Canada, 97—How it crossed Lake Michigan, 97—It will probably spread through Ontario unless preventive measures are taken, 98—Excellent chance to prevent its spread in Canada, 98—The Paris green remedy, 99—It is efficient if judiciously applied, 99—It does not affect the tuber, 99—Natural checks to the increase of the Potato-beetle 100—The Great <i>Lebia</i> destroying the larvæ, 100—Bogus experiments, 100—The true Remedy, 101—How to prevent the insect from becoming too numerous, 101—Planting early varieties of potatoes, 101.	
The Codling Moth again	101
Hay-bands around the trunk of the tree more effectual than rags placed in the fork, 102—The Codling Moth is single-brooded in the more northern countries, but double-brooded in the latitude of St. Louis, 102—Sexual differences of the moth, 103—Sexual characters in the genera <i>Argynnis</i> and <i>Grapta</i> , 103—The Codling Moth also infests peaches, 103.	
The Corn Worm <i>alias</i> Boll Worm	104
Its geographical range, 104—Injury done by it to corn, 104—It attacks tomatoes and other plants, 105—Food-plants of the Stalk-borer, 105—The egg of the Corn Worm, 105—Mr. Glover's account of the habits of the Boll Worm, 106—The larva is very variable in color, 107—Its transformations, 107—Number of annual broods, 107—Amount of damage done by it, 107—Remedies, 108—Attracting the moth by sweets, 108—Heard's moth-trap, 109.	
The Fall Army Worm	109
Reports of its appearance in 1870, and how it was generally mistaken for the True Army Worm, 109—It was also mistaken for the Boll Worm, 111—Injury caused by it, 111—How it differs from the True Army Worm, 112—It is a very variable species in the imago state, 113—The Spiderwort Owllet-moth, and how it differs from the Fall Army Worm moth, 113—Number of annual broods and time of appearance of the Fall Army Worm, 114—The eggs and how they are deposited, 114—Preventive measures, 115—It is never injurious during two consecutive years, 115—Parasitic checks, 116—Description of the imago, 116; of the varieties and the earlier states, 117.	
The Apple-tree Tent-caterpillar, or American Lackey-moth	11
The web-nests of the caterpillar and importance of their destruction, 118—The egg-mass, 118—The caterpillar and its habits, 119—Transformations of the insect, 119—The imago very variable in color, 119—Food-plants of the caterpillar, 120—Remedies, 120—Parasites and enemies, 120.	

	Page.
The Tent-caterpillar of the Forest	121
The egg-mass and how the eggs are deposited by the female moth, 121 — Development of the larva, 122 — Fitch's descriptions of the full-grown larva, 123 — Confusion arising from want of uniform rule in describing larvæ, 123 — The cocoon, 124 — The chrysalis and the moth, 124 — The web spun by the caterpillar, 124 — Mr. Ferris's observations on differences in habits, appearance, and food-plants of the caterpillar, 125 — Phytophagic varieties or species, 127 — Food-plants of the caterpillar, 127 — Its destructive powers, 127 — Remedies, 128 — Natural enemies and parasites, 128 — Summary, 129.	
The Fall Web-worm	130
It is often mistaken for the Tent-caterpillars, 130 — It feeds upon almost every kind of trees and shrubs, 130 — The web spun by the worm, 130 — General appearance of the worm, 130 — The chrysalis and imago, 131 — Number of annual broods, 131 — Plants it prefers, 131 — How it differs from the Tent-caterpillar, 132 — Remedies, 132 — Description of the larva, 132.	
The Blue-spangled Peach Worm	132
Winter retreat of the larva, 132 — General appearance of the larva, 133 — Chrysalis and imago, 133 — <i>Callimorpha vestalis</i> Packard, synonymous with <i>C. fulvicosta</i> , 133 — Food plants, 134 — Description of the larva, 134.	
The Ash-gray Pinion	134
Food plants of the larva, 135 — Transformations of the insect, 135 — Characters of the moth, 135 — Description of larva and imago, 135 — Remarks on allied species, 136.	
BENEFICIAL INSECTS.	
The Glassy-winged Soldier-bug	137
It preys upon different species of leaf-hoppers, 137 — Its larva and pupa, 138 — How it seizes its prey, 138 — Coloration of the insect, 138 — It was never observed before to attack the leaf-hoppers of the Grape-vine, 139 — Habits of the <i>Phytocorida</i> , 139.	
INNOXIOUS INSECTS.	
The White-lined Morning Sphinx	140
Resemblance of the Moth to a Humming bird, 140 — Interest attached to the study of Lepidopterous larvæ, 140 — Larval variations in the same species, 141 — Food plants of the larva, 141 — The light and dark colored forms of the larva, 142 — Its geographical range, 142 — Parasite, 142.	
Two of our Common Butterflies	142
THE ARCHIPPUS BUTTERFLY	143
Synonymy of its specific name, 143 — Its geographical distribution, 143 — Characters of the <i>Danaida</i> , 143 — Sexual differences, 143 — Food plants, 144 — Hibernation, 144 — Two annual broods, 144 — Description of the egg, 144 — The larva and its larval changes, 145 — How the horns of the larva become longer at each moult, 145 — The full grown larva, 146 — Interest attached to the metamorphoses of insects, 146 — How the larva becomes a chrysalis, 147 — The hardened chrysalis, 147 — Duration of the chrysalis state, 147 — The issuing of the butterfly, 148 — Protective colors of insects, 148 — Nauseous odor of the Archippus Butterfly in all its stages, 149 — The Tachina-parasite of the Archippus larva, 149 — Action of the parasitized larva, 149 — How the Tachina larva and other insects prepare the lid of their puparia, 149 — Characters of this Tachina-fly, 150 — Difficulties of the study of the <i>Tachinaria</i> , 150 — Two forms occurring in <i>Tachina archippivora</i> , 150 — The Butterfly often congregating in immense swarms, 151 — Probable reasons of this assembling in swarms, 152.	

Two of our Common Butterflies—Continued.

Page.

THE DISSIPUS BUTTERFLY 153

Distinguishing characters of the Nymphalidæ, 153—Food plants and geographical range, 153—The egg, 153—Description of the egg, 154—Development of the larva, 154—Description of the mature and young larva, 154—The insect hibernates as young larva, 155—Case prepared by the larva for its winter quarters, 155—Modifications of the case, 156—Peculiar habit of the autumnal larvæ, 156—Parasites, 157—Tachina-fly, 157—The Disippus egg-parasite, 157—The Disippus Microgaster, 158.

MIMICRY AS ILLUSTRATED BY THESE TWO BUTTERFLIES, WITH SOME REMARKS ON THE THEORY OF NATURAL SELECTION 159

Conformity of color between animals and their surroundings, 159—Definition of the term "mimicry," 160—Pungent odor possessed by the *Danaidæ*, 160—Their mode of flight, 160—Protection they derive from their peculiar odor, 161—*Pieridæ* and *Danaidæ* in the Valley of the Amazon, 161—Mimetic forms of *Pieridæ*, 161—Explanation of the origin of mimetic forms, 162—Mimicry between the Archippus and Disippus Butterflies, 163—The Ursula Butterfly, 163—Its caterpillar and chrysalis undistinguishable from those of the Disippus, 163—Its imago has no protective color, 164—Mr. Bennett's objections to the theory of Natural Selection producing mimetic forms, 165—Mr. Scudder's objections, 166—Discussion of Mr. Scudder's arguments, 167—Mr. Murray's objections to the connection between mimetic resemblances and Natural Selection, 170—Natural Selection not the only power producing mimicry, 171—Reasons for discussing in this Report the theory of Natural Selection, 172—Natural Selection involves belief in the doctrine of Evolution, 173—Darwinism is neither irreligious nor atheistic, 174.

REPORT IV.

[Submitted December 2, 1871; published April, 1872.]

Preface 3**NOXIOUS INSECTS.****Notes of the Year** 5**THE COLORADO POTATO-BEETLE** 5

Its injuries in 1871, 5—Its appearance in great numbers in early spring, 5—Exorbitant price of Paris green, 6—Natural enemies of the beetle very abundant, 6—Diminution in numbers of the beetle later in the season, 7—Causes of such diminution, 7—Damage caused by the Potato-beetle in Missouri, 7—It invaded Canada in 1870, 8—The Three-lined Potato-beetle mistaken for it in New York and Massachusetts, 8—Its further spread eastward irresistible, 8—Slow spread of the insect in the South, 9—Its present extent northward, 9—It spreads but does not leave the districts already invaded, 9—It is not injurious to potatoes in Colorado at a certain altitude, 10—New food-plants, 10—It feeds upon cabbage, 11—Its hibernation, 11—Objections raised against the use of Paris green, 11—Paris green is an efficient remedy and now in general use, 12—Box for dusting Paris green, 12—Mixing the poison with diluents, 12—No serious cases of poisoning have come to knowledge, 13—Antidote for Paris green, 13—Other applications, 13—Messrs. Saunders's and Reed's experiments with various substances, 14—Experiments with decoctions of various plants, 15—Air-slacked lime as a remedy, 15—Mechanical means, 15—Squire's Brushing machine, 15—Creighton's

Notes of the Year—Continued.**THE COLORADO POTATO-BEETLE.**

Improved Patent Insect Destroyer, 15—Disadvantage of all mechanical means, 16—A simple and effective way of brushing off and killing the bugs, 16—Natural enemies increasing, 16—Chickens acquiring a taste for eggs and larvæ of the beetle, 16—Spiders are among its enemies, 17—The 15-Spotted Ladybird and its larva, 18—The Icy Ladybird, 18—The Ring-banded Soldier-bug, 19—The Dotted-legged Plant-bug, 19—The Spined Soldier-bug and its earlier states, 20—The Nebraska Bee-killer, 21—The Kansas Bombardier-beetle, 21—Rove-beetles of the genera *Philonthus* and *Quedius*, 21.

THE CODLING MOTH AGAIN 22

Time of year that the first moths appear, 22—Time required for development, 22—Proper time to apply the bandages around the tree, 22—It attacks peaches, 22—Best kind of bandages, 23—Wier's Apple-worm Trap, 23—Advantages and disadvantages of the trap, 24—Overestimating the value of Wier's trap, 25—Jarring, 25—Mr. Chapin's method of knocking down the wormy apples, 26—When this operation should begin, 26—Fires, lights and bottles of liquid not to be recommended as a remedy, 27—Worthlessness of Todd's book "The Apple Culturist," 28—Natural enemies, 28—The Pennsylvania Soldier-beetle and its larva, 28—The Two-lined Soldier-beetle and its larva, 29—Description of the larva of *Telephorus bilineatus*, 30—Summary, 30.

THE PERIODICAL CICADA 30

Reproduction, with corrections and additions, of the Chronological table of Broods I to VI from Report I, 31.

THE GRAPE-VINE COLASPIS AGAIN 34

Redescription of the larva from well-preserved specimens, 34.

The Harlequin Cabbage-bug 35

It was not known in Missouri prior to 1870, 35—Its geographical range and color variations, 35—Insect enemies of the cabbage plant, 35—Dr. Lynceum's account of its habits and injury caused by it in Texas, 36—Its appearance in Missouri in 1870, 36—The egg, 37—The larva and pupa, 37—Several annual broods, 37—The mature bug, 37—Injury caused by it, 37—Its congeners in Europe, 38.

The Rascal Leaf-crumpler 38

Its proper scientific name, 38—It is hardly noticed in summer time, 38—Injury caused by it; 39—It hibernates as larva, 39—Habits of the larva, 39—The larval case, 39—Characteristics of the moth, 39—Food plants, 39—Remedies, 40—Natural enemies, 40—LeBaron's description of *Tachina phycita*, 40—*Limneria fugitiva*, 41—Description of imago, larva and chrysalis of the Rascal Leaf-crumpler, 41—Description of the variety *nebulella*, 42.

The Walnut Case-bearer 42

Other case-bearers enumerated, 42—The case of the Walnut case-bearer, 42—Differences between the moth and that of the Rascal Leaf-crumpler, 43—Natural enemies, 43—Description of *Perilitus indagator*, 43.

The Apple-leaf Skeletonizer 44

Its work on the leaves of Apple trees, 44—The worm and the chrysalis, 44—Appearance of the moth, 45—Mr. Hammond's account of the injury caused by the worm, 45—The European *Acrobasis consociella*, 45—Remedies and parasites, 45—Description of imago, larva and pupa, 46.

The Green Apple Leaf-tyer 46

It occurs almost always in company with the foregoing, 46—Characters and habits of the worm, 46—The Chrysalis, 47—Description of imago, larva and chrysalis, 47.

The Lesser Apple Leaf-folder	47
Its larva and pupa closely resembles those of the foregoing species, 47 —	
Mr. Wier's account of its habits, 48 — Remedy, 49.	
The Apple-leaf Bucculatrix	49
It is not very injurious in Missouri, 49 — Account of damage caused by it	
in New York, 50 — The worm and its habits, 50 — Its transformations,	
50 — Season of the appearance of the moth, 50 — Remedies, 50 — Hab-	
its of <i>Bucculatrix thuiella</i> , 51 — Description of larva and pupa of the	
Apple-leaf Bucculatrix, 51.	
The Apple-twig Borer	51
Its frequent occurrence in Missouri, 51 — Characters of the beetle, 52 —	
The holes made by it in the twigs, 52 — The holes are made only for	
food and protection, 52 — The insect breeds probably in the sap-wood of	
forest trees, 52 — The larva of <i>Sinoxylon bassillare</i> mistaken for that of	
the Apple-twig Borer, 52 — Remedy, 53.	
Insects injurious to the Grape-vine	53
THE RED-SHOULDERED SINOXYLON	53
Characteristics of the insect as imago, larva and pupa, 54 — Damage done	
by it to grape-vines, fruit trees and Hickory, 54 — Description of the	
larva and pupa, 54.	
Grape Disease	55
THE GRAPE-LEAF GALL-LOUSE	55
Its scientific name, 55 — The law of priority, 55 — European grape-vines	
valueless in the eastern U. S., 55 — Deterioration of some of our native	
vines, 56 — Climatic reasons for the failure of European vines, 56 —	
The principal cause of this failure is the Phylloxera, 56 — Further	
proof of the identity of the American with the European insect, 57 —	
Reasons for the identity of the Gall-louse with the Root-louse, 57 —	
Further facts respecting the habits of the Root-louse, 58 — Underground	
forms, 58 — The young lice and their habits, 59 — Hibernation, 59 —	
The pupa, 59 — The winged female, 59 — Susceptibility of different	
vines to the attacks of the louse, 60 — Classification of the North Amer-	
ican grape-vines according to their practical importance, 60 — Synop-	
sis of the True Grape-vines of the U. S., by Dr. George Engelmann,	
60 — Difficulty of separating the cultivated varieties of grape-vine,	
61 — Importance of a proper classification of cultivated grape-vines,	
62 — Importation into Europe of resisting American vines, 62 — Enum-	
eration of the cultivated varieties and their susceptibility to the dis-	
ease, 63 — No variety is entirely exempt from the attacks of the root-	
louse, 64 — American vines which resisted the root-louse in Europe,	
64 — Means of contagion from one vine to another, 64 — The spread of	
the root-lice from one vine to another, 64 — Transportation of the louse	
upon the roots of seedlings and cuttings, 64 — Spread of the disease in	
France, 64 — The winged female of the root-louse and her function,	
65 — The vernal leaf-gall, 65 — Preference of the winged Phylloxera for	
the Clinton grape and its allies, 65 — Power of flight of <i>Phylloxera car-</i>	
<i>ryæfolia</i> , 66 — Deposition of the eggs upon the leaf, 66 — Probable rea-	
sons why the injuries of the Phylloxera are greater in Europe than in	
America, 66 — Outward and more visible effects of the root-disease,	
67 — Practical suggestions, 67 — No need to destroy the Clinton vines,	
67 — Influence of soil on the intensity of the disease, 67 — Remedies,	
68 — Destruction of the gall-lice, 68 — Destruction of the root-lice, 68 —	
Results of experiments in France with various substances, 68 — Irriga-	
tion and submersion, 69 — Résumé of the insect's history, 69 — No need	
of unnecessary alarm, 70.	

BENEFICIAL INSECTS.

	Page.
Silkworms	72
INTRODUCTORY	72
The <i>Morus multicaulis</i> fever and its reaction, 72—Increasing attention lately given to silk-culture in America, 72—North America well adapted to the raising of silk, 73—General outlines of the natural history of the eight species of Silkworms treated of in this Report, 74.	
THE MULBERRY SILKWORM	75
Its past history, 75—Earliest silk-culture in China and India, 75—Its introduction into Europe, 76—Value of silk produced in France, 76—The "Silk Supply Association" in England and its objects, 76—Countries exporting raw silk, 77—The name given to silk by different nations, 77—History of the Mulberry Silkworm in America, 77—Its introduction and failure of earlier efforts, 77—Renewal of silk-culture within the past decade, 77—Silk manufacture in the United States, 78—Favorable prospects for raising silk in this country, 78—Silk-growing in California, 79—Mr. Prevost's "California Silk-grower's Manual," 79—False statements and exaggerations in Prevost's book, 79—Sale of Californian Silkworm eggs, 80—Disastrous effect of the Franco-Prussian war on the egg trade, 81—Success of silk-culture in California dependent on the ability to reel the silk, 81—Silk-culture in Kansas, 82—Mons. Boissière's silk establishment and its chances of success, 82—Silk-growing in Missouri, 83—The fall season in Missouri eminently propitious for rearing silkworms, 84—Natural history of the Silkworm, 84—Races of the Silkworm produced by domestication, 84—Effects produced on the insect by domestication, 85—The egg, 86—Larva and larval changes, 86—Cocoon, chrysalis and moth, 87—No insect parasite of the silkworm in Europe, 87—The "Uji" disease in China and Japan, 87—Diseases of the Silkworm, 88; The <i>Muscardinæ</i> , its effect and cause, 88; The <i>Pébrine</i> disease, its symptoms and cause, 89; Nature and origin of these diseases, 90—Other diseases of the Silkworm, 91—Best varieties or races, 90—Different forms of cocoons produced by different races, 92—How best to rear silkworms, 92—Rearing a very simple process, 92—Character of climate of the Japanese silk districts, 93—Keeping the eggs during the winter, 93—Hatching of the eggs, 93—Room and building for the rearing of the worms, 93—The feeding net or fillet, 94—Importance of carrying all the worms simultaneously through their moults, 94—Regularity of feeding, 95—Regulating the temperature, 95—Cocoonery, 96—Choking the chrysalis, 96—Egg-laying, 97—Selecting and fastening the cocoons for breeding purposes, 97—Treatment of the female moths after copulation, 97—Preservation of the eggs, 97—Reeling, 98—Great skill required to accomplish the work properly, 98—Classification of raw silk, 98—Preparing the cocoons for reeling, 98—Objects of and manipulations in reeling, 99—Best food for the worms, 100—Varieties of the Mulberry, 100—Cultivation of the Mulberry, 100—Osage Orange as silkworm food, 100—Introduction of the Osage Orange into France, 100—Experiments in America with feeding silkworms on Osage Orange, 101—Advantages and disadvantages of the Osage Orange, 102.	
THE CECROPIA SILKWORM	103
Changes made in its scientific generic name, 103—General appearance of the moth, 103—Fitch's explanation of the specific name, 104—Food plants, 104—The cocoon, 104—Value of its cocoon as compared with that of the <i>Polyphemus</i> moth, 105—How the moth issues from the co-	

Silkworms—Continued.**THE CECROPIA SILKWORM.**

coo, 105—The moth immediately after hatching, 106—The egg, 106—Description of the larval changes, 106—Strange habit of birds of using the empty cocoon as a storehouse, 107—The Cecropia worm cannot be classed as an injurious insect, 107—*Samia columbia* ought to be considered a variety of *cecropia*, 107—Parasites, 107—The Long-tailed Ophion, 107; its mode of oviposition, 108; habits of its larva, 108—The Cecropia Tachina-fly, 108; how it affects its victim, 108; its larva and imago, 109—The Mary Chalcis-fly, 109; how it escapes from the cocoon of the moth, 109; description of the imago, 110—The Cecropia Cryptus, 110; its habits, 110; description of the two sexes, 111; how it differs from the allied species, 111.

THE ALIANTHUS SILKWORM..... 112

Difference between the silkworms of the Castor-bean and Ailanthus, 112—Introduction of the Ailanthus silkworm into Europe, 113—Ailanthiculture in Europe, 113—Its introduction into America, 114—Disadvantages of the Ailanthus silkworm, 115—Its acclimatization in America and Australia, 115—Value of the cocoon, 115—Mr. Forgemol's device for unwinding the cocoon, 116—Natural history of the Ailanthus silkworm, 117—The egg and mode of egg-laying, 117—Larval changes, 117—Pupation, 118—The imago and its variations, 118—Food plants, 118—Directions for raising the worms, 119—A good word for the Ailanthus tree, 120.

THE PROMETHEA SILKWORM 121

Value of the cocoon, 121—Mode of egg-laying, 121—Larval changes, 121—How the cocoon is fastened to the twig, 122—Striking sexual difference in the moth, 122—*Callosamia angulifera* ought not to be considered as a different species, 122—Food plants of the worm, 123—Natural enemies, 123.

THE LUNA SILKWORM 123

The beautiful appearance of the moth, 123—The cocoon, 124—Food-plants, 124—Larval changes, 124—Season when the imago issues, 125—No parasites of the worm known, 125—*Actias selene* probably identical with *luna*, 125.

THE POLYPHEMUS SILKWORM 125

Mode of egg-laying, 125—The egg, 126—Food-plants, 126—Larval changes, 126—The cocoon, 126—Mr. Trouvelot's account of the issuing of the moth, 127—Wonderful vitality of the chrysalis, 127—Characters of the moth and its variations, 128—The broad antennæ of the male moth mistaken for a third pair of wings, 128—Difficulty of reeling the cocoon, 129—Number of annual broods, 129—Parasites, 129.

THE YAMA-MAI SILKWORM..... 130

Its native home and food-plant, 130—Its introduction into Europe and Australia, 130—Attempts at raising it in America, 130—The egg and how it should be kept over winter, 131—Climate most favorable for the worm, 131—The worm and its resemblance to the leaf, 132—Food plants, 132—Larval changes, 132—The cocoon and the value of its silk, 133—The moth and its habits, 133—Difficulties of rearing the worm, 133—Mr. Adams's account of rearing the Yama-mai Worm in Japan, 134—The Uji parasite, 136.

THE PERNY SILKWORM..... 137

Its native home, 137—How it differs from the preceding, 137—Larval changes, 137—The cocoon and its silk, 137—The moth, 137—Its culture in China, 138—The Tusseh Silkworm, 138.

	Page.
Silkworms —Continued.	
SUMMARY	138
Successful silk culture possible in this country, 138 — Comparative value of the different species of silkworms, 138.	
INNOXIOUS INSECTS.	
The Horned Passalus	139
Its frequent occurrence in old logs, 139 — The noise produced by the beetle, 139 — It occurs only in decaying wood, 140 — The larva and its exceptional character, 140 — Description of the larva, 140 — Previous descriptions of <i>Passalus</i> -larvæ, 141 — Description of the pupa, 141.	
The Great Leopard Moth	141
Characters of the larva, 141 — Food-plants, 142 — Hibernation and transformations, 142 — The imago, 142 — The larva able to resist extreme cold, 143 — Description of the larva, 143.	
The Isabella Tiger Moth	14
Characters of the larva, 143 — Food-plants, 143 — Cocoon and chrysalis, 143 — The moth, 144 — The popular name "Fever-worm" in the South, 144 — No parasite known of this and the preceding species, 144.	
The Acorn Moth	144
The egg laid in acorns that have been ruined by <i>Balaninus rectus</i> , 144 — Habits of the larva, 144 — Characters of larva and moth, 145 — Description of imago, larva and pupa, 145.	

REPORT V.

[Submitted December 2, 1872; published April 18, 1873.]

Preface	3
ENTOMOLOGY, ITS RELATIONS TO AGRICULTURE AND ITS ADVANCEMENT ...	5
Definition of Entomology, 5 — The term "insect," 5 — The four Subkingdoms of the Animal Kingdom, 6 — Characteristics of insect's, 7 — Classification of insects, 8 — Hymenoptera, 9 — Coleoptera, 10 — Lepidoptera, 11 — Hemiptera, 12 — Diptera, 13 — Orthoptera, 14 — Neuroptera, 14 — Osculant and aberrant groups, 15 — Importance of entomology as a study, 17 — Economic importance of entomology, 18 — Relation of insects to Agriculture, 18 — Damage inflicted by insects to Agriculture and Horticulture, 19 — Progress of economic entomology, 19 — Economic entomology in Europe, 19 — Insects in America much more injurious than in Europe, 21 — State entomologists and entomologists in public positions in the United States, 21 — How to counterwork noxious insects, 23 — Prevention, 24 — Checking the spread of injurious insects, 24 — Cure, 25 — Modification of Dr. Hull's Curculio-catcher, 25 — Encouragement of the natural enemies of injurious insects, 26 — Duties of a State Entomologist, 27 — Annual report, 27 — Correspondence and other duties, 28 — How to collect, preserve and study insects, 29 — Appliances for collecting, 29 — Use of the umbrella, 29 — The knapsack, 30 — The hand-net, 30 — The frame of the net, 30 — The bag of the net, 31 — Use of the sieve, 31 — Sugaring, 32 — Attracting moths by light, 32 — How to kill insects, 32 — The cyanide bottle, 32 — Use of chloroform, 33 — Entomotaxy, 34 — Insect pins, 34 — How to pin insects, 34 — How to mount small insects, 34 — Spreading board, 35 — Drying box, 36 — Insect boxes and cabinet, 37 — Mr. Lintner's boxes for Lepidoptera, 38 — Substances for lining insect boxes, 40 — Preserving insects in the collection, 41 — Relaxing specimens, 41 — Breeding insects, 41 — Breeding-cage, 42 — Note-book of the collector, 43 — How to transmit insects, 44 — Text-books, 44.	

NOXIOUS INSECTS.

	Page.
Notes of the Year	46
THE CODLING MOTH.....	46
Experiments with Wier's Apple-worm trap, 46 — Value of different materials for bandages, 47 — Jarring, 48 — Occurrence of the Apple-worm in California, 49 — Enemies and parasites, 44 — The Ring-legged Pimpla, 49 — The Delicate Long-sting, 50 — Other enemies, 51 — Efficiency of the Spined Soldier-bug, 51 — False doctrines for exterminating the Codling Moth, 51.	
THE COLORADO POTATO-BEETLE.....	52
Its comparative harmlessness in 1872, 52 — New food-plants, 52 — Its progress eastward up to 1872, 52 — Experiments with Paris green, 53 — New enemies, 53 — The Rust-red Social Wasp, 54 — The Rose-breasted Grosbeak, 54.	
THE APPLE-TWIG BORER.....	54
It attacks also pear twigs, 54 — It has been bred from grape-canecanes by Dr. Shimer, 54.	
EGG OF THE HORNED PASSALUS	55
The egg, 55 — The newly hatched larva, 55 — Rapid development of the insect, 55.	
EGG OF THE COMMON MAY BEETLE	55
Description of the eggs and how they are deposited, 55.	
EGG OF THE BROAD-NECKED PRIONUS.....	56
Characteristics of the eggs and where they are deposited, 56.	
EGGS OF AMERICAN TENT-CATERPILLAR	56
Correction of the figure given in Report III of the egg-belt, 56.	
COUNTERWORKING THE TOBACCO WORM	56
Mr. White's method of planting the Jamestown Weed among the potatoes and poisoning the blossoms thereof, 56.	
The Grape Phylloxera	57
Its popular name, 57 — Accounts of the unusual mortality among grape-vines in the spring of 1872, 57 — Causes of this mortality given in the accounts, 59 — Excessive drouth and overbearing, 60 — The Phylloxera is the true cause, 60 — Actual proof of the Phylloxera having caused the mortality among grape-vines, 61 — Influences that favored the increase of the lice in 1872, 61 — Importance of a full understanding and management of the Phylloxera, 62 — Its range in North America, 62 — Its spread in Europe, 63 — Inconstancy in the habits of the gall-lice, 63 — The leaves of Clinton vine no longer affected by the gall-lice since 1871, 63 — Method of formation of the leaf-gall, 64 — Relative immunity of American vines in Europe, 64 — Propagating American varieties from cuttings, 65 — Appreciation of American vines in Europe, 66 — Careless statement published as to the immunity of <i>Labrusca</i> -vine, 66 — Grafting the grape-vine, 67 — New theories, 67 — The Phylloxera is the true cause and not the effect of the disease, 67 — Mr. Laliman's theory that the insect has always existed in Europe, 68 — <i>Oidium Tuckeri</i> of Europe and America identical, 69 — Mr. Saunders's account of the presence of <i>Oidium Tuckeri</i> in America, 70 — Means of contagion of the disease from one vine to another, 69 — Flying capacity of the winged Phylloxera, 70 — The male louse, 71 — Remedies, 71 — Efficacy of carbolic acid and soot, 71 — Value of submersion or irrigation, 72 — Sprinkling with quick-lime, ashes, etc., 72 — Mr. Lichtenstein's experiments to allure the lice, 72 — Experiments with carbolic acid, 73.	

	Page.
The Oyster-shell Bark-louse of the Apple	73
Its occurrence in Missouri, 74 — Its appearance in Luray County, Missouri, 74 — Mr. Hanan's account of its spread, 75 — Its occurrence in Southern Missouri, 76 — Its occurrence in Mississippi and Georgia, 78 — Its appearance in Kansas, 79 — It is double-brooded in the South, 79 — The waxy secretion of Homoptera, 80 — The newly hatched louse, 80 — The larval scale, 81 — Development of the female scale, 81 — Growth of the male scale, 82 — The male louse, 83 — Rare occurrence of the winged male, 84 — Agamic multiplication, 85, — Mode of spreading, 85 — Food-plants, 86 — Varieties of the Apple tree preferred by it, 86 — Enemies and parasites, 87; Mites, 87; <i>Aphelinus mytilaspidis</i> and Dr. Le Baron's account of its habits, 88 — Easy transportation and introduction of the <i>Aphelinus</i> , 90 — Remedies, 90 — Application of oily substances, 90 — Bibliographical and Descriptive, 91 — The generic name, 91 — Signoret's classification of the <i>Coccidæ</i> , 92 — Specific name, 92 — Characteristics and habits of three allied species, 93 — A new name necessary for our apple-tree species, 94 — Description of the eggs and the winged male, 95; of the male and female scale and of the female louse, 96.	
The Pine-leaf Scale-insect	97
Nature of the malady caused by it, 97 — Natural history of the insect, 98 — The male, 99 — There are two annual broods, 99 — It is confined to the Pines proper, 100 — Natural enemies, 100; The Twice-stabbed Ladybird, 100; The Painted Ladybird and description of its larva, 101 — Remedies, 101 — Stripping the old leaves, 102 — Application of powdered and liquid substances, 102.	
The Hickory Bark-borer	103
Accounts of the damage caused by it in Missouri, 103 — Habits of the European <i>Scolytus destructor</i> , 104 — Various kinds of Hickory attacked by the Hickory Bark-borer, 105 — Its natural history, 105 — Natural enemies, 106 — Descriptions of the Three-banded <i>Spathius</i> , 106 — Mr. Cresson's description of <i>Bracon scolytivorus</i> , 106 — Remedies, 107 — Description of the imago, 107 — Is it different from <i>Scolytus 4-spinosus</i> ? 107.	
The Rose Chafer	108
Great damage caused by the beetle in 1872, 108 — Remedy, 109 — Harris's account of its natural history, 109.	
The False Chinch-bug	111
It was not known as injurious before 1872, 111 — Accounts of injury done by it, 111 — How it differs from the true Chinch-bug, 112 — Its probable natural history, 112 — Description of imago, larva, and pupa, 113 — Variation in the imago, 113 — Its great abundance in the Fall of 1872, 114.	
Insects Injurious to the Grape-vine	114
THE GRAPE-VINE APPLE-GALL	114
The breast bone of Gall-gnat larvæ, 114 — The gall mistaken for an apple, 114 — Form of the gall, 115 — Habits of the larva, 116.	
THE GRAPE-VINE FILBERT-GALL	116
Appearance of the gall, 116 — Larva of the gall-maker, 117.	
THE GRAPE-VINE TOMATO-GALL	117
Its curious resemblance to a tomato, 117 — Various shapes assumed by it, 118 — The larva, 118 — Enemies of the larva, 118.	
THE GRAPE-LEAF TRUMPET-GALL	118
Characteristics and occurrence of the gall, 118.	

	Page.
Eggs in and on canes and twigs	119
Probable eggs of the Jumping Tree-cricket, 119 — The egg-punctures on grape-cane, 119 — Characters of the egg, 119 — General appearance of the cricket, 120.	
Eggs of the Snowy Tree-cricket, 120 — Trees and shrubs attacked by this cricket, 120 — The egg, 120 — Habits and natural history, 120 — Injury done by it, 121 — The eggs mistaken by Fitch for those of the Buffalo Tree-hopper, 121.	
Egg-punctures of the Buffalo Tree-hopper, 122 — Development of the larva, 121 — Characters and habits of the perfect insect, 122 — Egg-punctures of some unknown Tree-hopper, 122.	
Egg-punctures of the Frosted Lightning-hopper, 122 — Development and habits of the insect, 122.	
Egg-punctures probably of <i>Orchelimum glaberimum</i> , 123 — The egg, 123 — Characters and habits of the imago, 123.	
Eggs of the Oblong-winged Katydid, 123 — They have been mistaken by Harris for those of the Broad-winged Katydid, 123 — Ovipositors and modes of egg-laying in the three Katydids occurring in Missouri, 124 — Increase in thickness of Katydid eggs before hatching, 124.	
Stinging larvæ	125
The Potato-worm falsely considered as a stinging caterpillar, 125 — General harmlessness to man of insect larvæ, 125 — Stinging caterpillars in Europe and North America, 126 — List of such larvæ in U. S., 126 — Description of larva and chrysalis of <i>Acronycta xylinoides</i> , 126.	
THE BUCK MOTH OR MAIA MOTH	127
Flight and characteristics of the moth, 127 — The egg and mode of egg-laying, 128 — Appearance of the full-grown larva, 129 — Larval changes, 129 — Color variations of the larva, 130 — Habits of the young larva, 130 — The sting of the larva, 131 — The pupa, 131 — Issuing of the moth, 132 — Irregularity and retardation in development, 132; the species benefits thereby, 132 — Food plants, 132 — Natural enemies, 132.	
THE IO MOTH	133
The male and female moth, 133 — The egg, 134 — The larva and its urticating power, 134 — Larval changes, 135 — Pupation, 135 — Food plants, 136 — Parasites, 136.	
The Green-striped Maple-worm	137
Account of its occurrence in great numbers in Kansas, 137 — Injury done by it to Soft maples, 138 — The egg, 138 — Larval changes, 138 — The chrysalis, 139 — The imago, 139 — Natural enemies, 139 — Description of <i>Belvoisia bifasciata</i> , 140 — Remedies, 141.	
INNOXIOUS INSECTS.	
The Hellgrammite Fly	143
The eggs, 143 — Respiratory apparatus of the larva, 143 — Habits of the larva when about to transform, 143 — The pupa, 144 — Sexual difference in the imago, 145.	
The Goat-weed Butterfly	145
The egg, 146 — Habits of the larva, 146 — Larval changes, 146 — Transformation, 147 — New food-plant, 147 — Simulation of the color of the food-plant by the larva, 147 — Two annual broods, 148 — Hibernation of the imago, 148 — Natural enemies, 149.	

	Page.
On a new genus in the Lepidopterous Family Tineidæ with remarks on the fertilization of <i>Yucca</i>	150
Generic characters of <i>Pronuba</i> , 150 — Description of <i>Pronuba yuccasella</i> , 151 — Plants requiring the aid of insects for fertilization, 152 — Fertilization of Orchids, 152 — Fructification of <i>Yucca</i> , 153 — <i>Yuccas</i> must rely on insects for fertilization, 153 — Insects frequenting <i>Yuccas</i> , 154 — Diurnal and nocturnal habits of <i>Pronuba</i> , 154 — How the female moth fertilizes the plant, 154 — Oviposition, 155 — The larva within the young fruit, 155 — Description of the larva, 155 — Only a small percentage of fruit not infested by the larva, 156 — The larva leaves the capsule and enters the ground for hibernation, 156 — Mutual adaptation of plant and insect, 156 — The moth doubtless occurs wherever <i>Yuccas</i> grow wild, 157 — Easy transportation of the cocoon, 158 — Further facts regarding the fructification of <i>Yucca filamentosa</i> and <i>gloriosa</i> , 158 — <i>Yuccas</i> seedling in Europe, 159 — Range of the insect, 159 — Mr. Stainton's opinion on the characters of the <i>Yucca</i> moth, 160.	

REPORT VI.

[Submitted December 2, 1873; published March, 1874.]

Table of Contents	3
Preface	6

NOXIOUS INSECTS.

Notes of the Year	9
THE CODLING MOTH	9
Failure of the apple crop in 1873, 9 — Dr. LeBaron's observations on the habits of the worm, 9 — Proportion of worms leaving the fruit before it falls, 10 — How it affects pears, 10 — Time and method of using bandages, 10 — Westward spread of the insect, 10.	
THE COLORADO POTATO-BEETLE	11
How it has affected the price of potatoes, 11 — New food-plants, 11 — Its progress eastward during 1873, 12 — Improved methods of using Paris green, 13 — Device for jarring off the bugs, 14 — European publications on the insect, 15 — Danger of its introduction into Europe, 15 — Precautionary measures to be taken in Europe, 16.	
THE COTTON WORM	17
Paris green suggested as remedy, 17 — Address before the National Agricultural Congress, 17 — Mr. Glover's summary on experience with Paris green, 19 — Experiments with the poison, 19 — Johnson's Sprinkling machine, 20 — Patents on Paris green, 20 — The Royall mixture, 21 — Hibernation of the insect, 22 — Natural enemies, 23 — Geographical range, 23 — Position of the moth when alighting, 24.	
THE CANKER WORM	24
Dr. LeBaron's summary of remedies, 24 — Mr. Milliken's experience with the rope and tin trap, 25 — The Paris green remedy, 26 — A new trough, 26 — Birds which destroy the worm, 27 — Mr. Mann's observations on the insect, 28 — Two species have hitherto been confounded, 28 — The English Sparrow and the increase of the White-marked Tussock-moth, 29.	
Insects injurious to the Grape-vine	30
THE GRAPE PHYLLOXERA	30
The term "Phylloxera", 30 — Bibliographical history, 30 — Characters of the genus and its position in the system, 33 — Biological history, 33 — Different forms which the insect assumes, 33 — The gall-inhabiting form, 34 — The root-inhabiting form, 38 — Balbiani's discovery of the	

Insects injurious to the Grape-vine—Continued.**THE GRAPE PHYLLOXERA.**

true sexual individuals and the winter egg of *Phylloxera quercus*, 41 — The winter egg not essential to the winter life of the Grape Phylloxera, 42 — Polymorphism in Phylloxera, 43 — Conclusive proof of the identity of the root- and gall-lice, 44 — Practical considerations, 44 — The more manifest and external effects of the disease, 44 — Mode of spreading, 45 — Swarming of winged specimens of *Phylloxera caryefoliae*, 45 — Power of flight in the Grape Phylloxera, 45 — Spread of the disease through the winged females, 46 — Susceptibility of different vines to the disease, 46 — Practical importance of knowing the more resisting and more susceptible vines, 46 — List of the cultivated species and varieties of vines indicating their relative susceptibility to Phylloxera, 47 — Prophylactic means of coping with the disease, 48 — Grafting the more susceptible onto the roots of resisting vines, 48 — Other preventive measures, 50 — Natural enemies, 50 — Insect enemies of the gall-louse, 50 — Enemies of the root-louse, 52 — The Phylloxera mite, 52 — Different forms assumed by mites in their development, 52 — *Hoplophora arcata*, 53 — Peculiarities of the *Oribatida*, 54 — Direct remedies, 55 — Submersion a perfect remedy, 55 — Application of pure insecticides without satisfactory results, 56 — Range of the insect in America, 57 — Injury caused by it in America, 58 — Reasons why the insect is more injurious in Europe, 59 — False theories, 60 — The Phylloxera is the cause and not the effect of the disease, 60 — It is a native American insect and has been imported into Europe, 62 — It is peculiar to the Grape-vine, 63 — The American Oak Phylloxera and its natural history, 64 — Conclusion, 65.

APPENDIX AND NOTES TO THE ARTICLE ON GRAPE PHYLLOXERA.....

66

Diagnosis of *Phylloxera vastatrix*, 66 — Influence of the insect's puncture, 67 — The supposed male of the gall-louse, 67 — The non-cultivation of the Clinton grape, 67 — Transient nature of the leaf-galls, 68 — Constancy of the differences between the forms assumed by the insect, 68 — Supposed sexual individuals, 68 — Number of generations annually produced, 69 — Number of molts, 69 — Transplanting root-lice on to the leaves, 69 — Nature of the swelling on the roots produced by Phylloxera, 70 — The true Grape-vines of the United States, by Dr. G. Engelmann, 70 — Exceptional instances where the European Vine has succeeded in America, 76 — Grafting the more susceptible onto the roots of the resisting varieties, 78 — Descriptions of *Tyroglyphus phylloxerae* and *Hoplophora arcata*, 81 — Efficacy of inundating the vineyards, 82 — Facts showing that the disease of Grape-vines in America is principally caused by Phylloxera, 82 — Description of *Phylloxera rileyi*, 86 — The true sexual individuals and the winter egg, 86.

THE BLUE CATERPILLARS OF THE VINE.....

87

1. The Grape-vine Epimenis, 87 — Habits and characters of the larva, 87 — Description of larva and chrysalis, 88.
2. The Beautiful Wood Nymph, 88 — Characters and food plants of the larva, 88 — The moth and the egg, 89 — Description of the egg and larva, 89 — Of the chrysalis, 90.
3. The Pearl Wood Nymph, 90 — Its larva almost undistinguishable from that of the foregoing species, 90 — Food-plant, 91 — Distinguishing characters of the moth, 91 — Mr. Lintner's description of the larva, 92 — Mr. Lintner on the difference between the larva of *Eudryas grata* and *E. unio*, 93.
4. The Eight-spotted Forester, 94 — Description of the larva, 94; Chrysalis and imago, 95.

	Page.
Insects injurious to the Grape-vine—Continued.	
THE BLUE CATERPILLARS OF THE VINE—Continued.	
Summary, 95—Comparison of the larvæ of these four species, 95—Remedies, 96.	
The Red-legged Ham-beetle	96
Its popular name, 96—It has been the cause of an interesting law-suit, 96; Entomological information necessary to a just verdict, 98—Another case before a jury requiring botanical knowledge, 98—Injury caused by the beetle in St. Louis, 99—The eggs, and how they are deposited, 99—The larva and its habits, 99—The pupa, 99—Prevention, 100—Other species associated with it, 100—Habits of other species of <i>Clerida</i> , 101—How <i>Macrobis ruficollis</i> saved the life of Latreille, 101—Description of the larva of <i>Corynetes rufipes</i> , 101—Description of the pupa, 102.	
The Clover-hay Worm	102
Its geographical distribution, 102—It has probably been imported from Europe, 101—Its past history and accounts of damage caused by it, 102—Its natural history, 105—Remedies, 105—Description of larva and chrysalis, 103; of the imago, 107—Its allied congener, <i>Asopia olinalis</i> , 107.	
The Legged Maple Borer	107
The burrows of the larva, 108—Appearance of the moth, 108—Remarks on the nomenclature of the species, 108—Injury caused by it to maples, 109—It attacks only trees already injured by some cause or another, 109—Remedies, 110—Description of imago, larva and pupa, 110.	
The Raspberry Root-borer	111
Work of <i>Obreia perepicollata</i> in canes of Raspberry and Blackberry, 111—Injury caused by the Root-borer, 111—General appearance and habits of the worm, 112—Description of imago and larva, 113.	
The Northern Brentian	113
Its occurrence and distribution, 113—Characteristics of the beetle, 114—Fighting habits of the males, 114—How the male assists the female in ovipositing, 115—How much time is required for the transformations of the insect, 115—Habits of the larva, 115—Description of the larva, 115; of the pupa, 116—Real position of the Brentians in the system, 116—The specific and generic names, 116—How another larva has been mistaken for that of the Northern Brentian, 117—Description of this larva, which evidently belongs to the Tenebrionidæ, 118.	
The Jumping Sumach-beetle	118
Sumach industry in Europe and America, 118—Species of sumach possessing economic value, 119—Appearance and habits of the beetle, 119—The egg-masses, 120—Development and habits of the larva, 120—Transformation, 120—The two annual broods, 120—Injury caused by it to the sumachs, 121—Geographical range, 121—Remedies, 121—Description of larva and pupa, 121—Variations of the beetle, 122.	

BENEFICIAL INSECTS.

The Unadorned Tiphia or White Grub Parasite	123
Other enemies of the White Grub, 123—Cocoon and larva of <i>Tiphia</i> , 123—It is undoubtedly a parasite of the White Grub, 124—Characters of the genus <i>Tiphia</i> , 124—Habits of <i>Tiphia femorata</i> , 124—Habits of the <i>Tiphia</i> larva, 124—Characters of the Unadorned <i>Tiphia</i> , 125—Beetle parasitic upon it, 125—Description of larva and imago, 126—The species has been described under three different names, 126.	

INNOXIOUS INSECTS.

	Page.
The Dominican Case-bearer	127
Characters of the beetle, 127 — Mode of oviposition, 128 — Oviposition of <i>Chlamys plicata</i> , 128 — The young larva and its food habits, 129 — The case of the larva, 129 — Characters of the larva, 130 — Time required for its development, 130.	
The Yucca Moth	131
Its natural history completed, 131 — Description of the chrysalis, 131 — Hatching of the chrysalis, 132 — Method of oviposition, 133 — Oviposition is followed by pollination, 134 — The egg in the young fruit and the embryo larva, 134 — It is the only insect that can well fertilize the Yuccas, 135.	
Hackberry Butterflies	136
The European Purple Emperor, 136 — Insufficient former account of their earlier states, 136 — Species of <i>Celtis</i> in Missouri, 137.	
THE EYED EMPEROR	137
The full-grown larva, 137 — Habits of the larva, 138 — Pupation, 138 — The imago, 139 — The egg and the young larva, 139 — Two annual broods, 139 — Hibernation of the young larva, 140.	
THE TAWNY EMPEROR	140
How it differs from the Eyed Emperor, 140 — The egg, 141 — Larval changes and habits, 141 — Egg parasite, 142.	
BIBLIOGRAPHICAL	142
The generic name, 142 — The specific names of the two species, 143 — Fabricius's original description of <i>Lycæon</i> and <i>Herse</i> , 144 — Other species of the genus in the United States, 145 — On the validity of <i>Alciot</i> , 145 — Descriptions of the earlier states of both species, 146 — Their popular names, 148 — The scientific specific names, 149.	
Katydids	150
General considerations, 150 — Spring in Europe and America, 151 — Stridulating noise produced by crickets and grasshoppers, 152 — Sounds inaudible to man, 152 — Grasshoppers, Katydids, Locusts, 153 — Habits and general appearance of our Katydids, 154 — They oviposit above ground, 154, — Their ovipositors not rudimental, 155.	
THE ANGULAR-WINGED KATYDID	155
It is the most common species in Missouri, 155 — General character of the insect, 155 — The eggs, 155 — Erroneous statement concerning the egg, 156 — How the female deposits the eggs, 156 — Number of eggs laid by the female, 158 — Hatching of the larva, 158 — Food of the larva, 158 — Changing from the pupa to the perfect state, 159 — Its song, 159 — It is capable of domestication to a certain degree, 160 — Description of the immature states, 161 — Natural enemies, 162 — The Back-rolling Wonder, an egg-parasite, 162 — Curious habit of the female <i>Antigaster</i> , 162 — Description of <i>Antigaster mirabilis</i> , 163 — Striking sexual differences, 163.	
THE NARROW-WINGED KATYDID	164
Distinguishing characters, 164 — Method of oviposition, 165 — The egg, 165 — Its song, 166 — Description of larva and pupa, 166.	
THE BROAD-WINGED KATYDID	167
It is the true Katydid, 167 — Distinguishing characters, 167 — Mode of oviposition as observed in confinement, 167 — Mr. Jaeger's erroneous statement regarding the oviposition, 168 — Its song, 168.	
THE OBLONG-WINGED KATYDID	169
It has not yet been found in Missouri, 169 — Distinguishing characters, 169 — The eggs not yet known, 169 — Abnormal female specimen, 169.	

REPORT VII.

[Submitted at time of publication, April, 1875.]

Page.

Preface.....	III
Table of Contents.....	VII

NOXIOUS INSECTS.

The Colorado Potato-beetle	1
Its gradual spread eastward, 1—It reached the Atlantic during the year 1874, 1—Injuries done during the year 1874, 2—Alarm about it in Europe, 3—Prohibiting the importation of American potatoes by European governments, 3—The insect probably introduced into Europe in the perfect form, 3—It would doubtless thrive in Europe if imported, 4—Its ravages exaggerated and underrated, 5—On the safety and advisability of the use of Paris green, 8—Past experience with the poison, 10—Influence of Paris green on the plant and on the soil, 11—Influence of the green on man indirectly through the soil or through the plant, 13—The beetle eats as well as the larva, 14—It passes the winter as imago, 14—New food-plants, 14—New means of destruction, 15—The Gray Sprinkler, 15—The proper scientific name of the beetle, 16—Mr. Carrière's ridiculous statements, 17.	
The Chinch Bug	19
Its disastrous work in 1874, 19—Circular distributed among farmers, 19—Appearance and transformations of the Chinch Bug, 20—The short-winged form, 20—Description of the Chinch Bug and its earlier states, 21—Its past history in America, 22—Its past history in Missouri, 22—Destructive powers of the Chinch Bug, 24—Its injuries in 1874, 24—Its injuries in Missouri in 1874, 25—Food-plants, 26—Time required for the complete development of various insects, 27—Number of annual broods, 27—Its rapid increase, 23—Where the eggs are laid, 23—Flight of the Chinch Bug, 29—Its migrations on foot, 30—Heavy rains destructive to it, 30—Direct remedies, 31—Irrigation, 31—Preventive measures, 32—Burning, 32—Rolling, 33—Manuring and early sowing, 34—Mixing seed, 34—Preventing the migration of the bugs from one field to another, 35—Importance of winter work and combined action, 36—Other possible remedies, 37—Abstaining from the cultivation of grains, 38—Natural enemies, 38; Ladybirds, 39; Lace-wing fly and habits of its larva, 40; The Insidious Flower-bug and the Many-banded Robber, 41—Birds destructive to the Chinch Bug, 41—Discussion of other proposed remedies and preventive measures, 41—The Chinch Bug injurious to stock, 43—Prognosticating, 44—Unnecessary fears, 44—Bugus Chinch Bugs, 45—The False Chinch Bug, 46—The Insidious Flower-bug and the Ash-gray Leaf-bug, 47—The Flea-like Negro-bug, 48—Recapitulation, 49.	
APPENDIX TO THE ARTICLE ON THE CHINCH BUG	51
List of correspondents who replied to the circular, 51—Questions answered by correspondents, 52—Answers given by correspondents, 53.	
The Flat-headed Apple-tree Borer	71
Extent of its ravages in fruit and shade trees, 71—Its natural history, 72—Natural enemies, 73—Chalcid larva, 74—The Cherished Bracon, 75—The Useful Labena, 75—Ants, 76—Remedies, 76—Keeping young trees vigorous and healthy, 77—Coating the trunks and larger branches with soap and other greasy substances, 77—Scraping, 78—Wrapping wire gauze around the trunk, 79—Cutting out the newly-hatched larva, 79.	

	Page.
Canker Worms	80
Confusion regarding the two species of Canker Worms, 80—Distinguishing characters of the Spring Canker-worm, 80—Description of egg, larva and chrysalis of <i>Anisopteryx vernata</i> , 82—How the Fall Canker-worm differs from the preceding, 83—Description of egg, larva, and chrysalis of <i>Anisopteryx pometaria</i> , 84—Practical importance of distinguishing the two species, 85—Comparative description of the Spring and Fall Canker-worms, 86—Conclusion, 88—Extracts from the original essay on the Canker Worm by W. D. Peck, 89.	
The Grape Phylloxera	90
Completion of its natural history, 90—The true sexual individuals discovered, 91—Epitome of the life-history of the Grape Phylloxera, 91—Different forms presented by the species, 93—Its power to change its habit, 93—Specific identity of the gall- and root-louse, 94—Untrustworthy experiments made by the Department of Agriculture, 95—Proof of the identity of the two forms, 95—The gall-louse is but a transient form, 96—Where do the winged females lay their eggs? 96—The winged female lays the egg wherever she is carried by the wind, 97—Particular part of the vine chosen by the winged female for laying her eggs, 98—The true sexual individuals, 98—Injury done by Phylloxera in America during the year 1874, 99—Range of the insect in America, 101—Does it occur in South Carolina and Georgia? 102—The Phylloxera in California, 103—Injury done during the year 1874 in France, 103—Its spread in Europe, 104—Direct remedies, 105—Natural enemies, 106—Susceptibility of different varieties of grape-vine, 106—Grafting as a means of counteracting the work of Phylloxera, 108—Underground grafting, 109—Methods of grafting above ground, 112—Roots to use as stock, 115—Varieties to graft, 116—American grape-vines abroad, 116.	
APPENDIX TO THE ARTICLE ON GRAPE PHYLLOXERA	117
Synopsis of the American species of the genus Phylloxera, 117—The American Oak Phylloxera, 118; Its natural history, 119—Description of <i>Phylloxera rileyi</i> and the different forms presented by it, 119—Further points in its life-history, 120.	
The Rocky Mountain Locust	121
Its natural history, 121—Method of egg-laying, 121—The egg, 122—The newly-hatched locust and its development, 123—Where the eggs are laid by preference, 123—The invading swarms are formed by a single species, 124—Differences between the Rocky Mountain and the Red-legged Locusts, 125—Mr. Thomas's description of the Red-legged Locust, 126—Variations, 126—Measurements of <i>Caloptenus femur-rubrum</i> , 127—Description of <i>Caloptenus spretus</i> and of its larva and pupa, 129—Measurements of <i>Caloptenus spretus</i> , 130—Summing up the difference between the two species, 132—Chronological history, 132—Locust invasions in the Old World, 132—Accounts of earlier locust invasions in America, 133—Chronological history of the Rocky Mountain Locust, 134—Earlier invasions, 135—Data regarding the invasion of 1867, 137—The invasion of 1873, 141—The invasion of 1874, 143—The invasion of 1874 in Missouri, 144—Questions addressed to correspondents in each county in Missouri regarding the locust, 144—Summary of the answers given by correspondents, 145—The invasion of 1874 in Kansas, 148—in Nebraska, 151—in Iowa and Minnesota, 153—in Colorado, 154—in Dakota and Manitoba, 155—Flight and ravages of a locust swarm, 156—Food plants, 158—Time of appearance of invading	

The Rocky Mountain Locust—Continued.

swarms, 160—Eastern limits of locust invasions, 161—Native home of the species, 162—Explanation of the migratory instinct, 164—This locust cannot thrive in the Mississippi Valley, 164—It is a subalpine insect, 165—What injury may be expected in Missouri in 1875, 166—Ravages of migratory locusts in the Atlantic States, 167—Description of the Atlantic Migratory Locust, 169—Differences between *Caloptenus spretus*, *differentialis* and *atlantis*, 170—Injury from other, non-migratory, locusts, 171—The Differential and Two-striped Locusts, 173—Enemies and parasites, 174—Birds destroying locusts or their eggs, 174—The Silky Mite, 175—The Locust Mite and Dr. LeBaron's description thereof, 176—The Anonymous Tachina-fly, 178—The Common Flesh-fly, 180—Remedies, 181—Classification of protective measures, 181—Natural agencies, 181—Destruction of the eggs, 181—Destruction of the young wingless locusts, 182—Driving off the winged locusts, 184—Further suggestions, 185—Locusts as food for man, 186—The popular and scientific names of the insect, 187—Prairie fires vs. the Rocky Mountain Locust, 189.

APPENDIX TO THE ARTICLE ON THE ROCKY MOUNTAIN LOCUST 191

Letters of three correspondents from Texas and Kansas regarding Locust invasions, 191.

REPORT VIII.

[Published May, 1876.]

Preface III
Table of Contents V

NOXIOUS INSECTS.

The Colorado Potato-beetle 1

Damage during the year, 1—Abundant in Atlantic States, 1—Swarming on Coney Island, 2—Injuring Egg-plant, 2—Its scientific name, 2—Additional enemies, 3—Eaten by the Crow, 3—Remedies, 3—Cost of applying Paris green, 3—Preparing the poison, 3—Use of straw as a protection, 4—Machine for sprinkling, 4—Machine for brushing off the insects, 4—Experience with Paris green, 5—Experiments of Profs. R. C. Kedzie and Wm. McMurtrie show that it may be used with safety, 6—Trial of other remedies, 6—The insect's native home, 8—The theory that it came from the Rocky Mountain Region essentially correct, 10—Poisonous qualities of the insect discussed, 10.

Canker Worms 12

Two species long confounded, 12—They differ generically; new genus (*Paleacrita*) proposed for one, 13—The two compared in all stages, 13, 14—Characters of the genus *Paleacrita*, 17—Distinguished as Spring and Fall Canker-worms, 17—Practical considerations from their differences of habit, 18—Stunting the larvæ does not produce male moths, 19—Traps recommended, 20, 21.

The Army Worm 22

Its generic name, 22—The term "Army-Worm" applied to various insects, 23—Past history of the Army Worm, 24—Known since 1854 in Missouri, 27—It followed the 1871 conflagration around Peshtigo, Wis., 28—Its history in 1875; very general all over the country, 28, 29—Its history in Missouri in 1875, 30—Sexual differences, 30—Sexual organs illustrated, 30, 32—Natural history of the species, 32—Illustrated in all states, 32, 33—It occurs in Europe, Asia, New Zealand, and Anstra-

The Army Worm—Continued.

lia, 34—Description of the egg, 34—Where the eggs are laid, 34—Conclusions drawn from structure, 36, 37—When the eggs are laid, 40—In what state does the insect hibernate?, 43—Habits of the Worm, 45—Why it escapes detection when young, 45—Why it travels in armies, 46—Time of its appearance, 46—Are there one or two broods?, 47—The Fall Army-worm, 48—How distinguished from the real Army Worm, 48—Plants preferred by the Army Worm, 49—Its sudden appearance and disappearance, 50—It swarms during wet preceded by very dry seasons, 51—Its natural enemies, illustrated, 52—Remedies, 54—Philosophy of winter burning, 54, 55—Prevention, 55—Summary of the leading facts concerning it, 56.

The Rocky Mountain Locust.....

57

Previous experience in spring 1867, 57—Predictions verified, 58—General outlook in spring of 1875, 60—Extent of country ravaged, 60—The outlook in Missouri, 61—Country ravaged often as bare as in midwinter, 61—Account by counties, 62—Atchison County, 62—Andrew County, 62—Benton County, 63—Barton County, 63—Bates County, 63—Buchanan County, 64—Caldwell County, 64—Cass County, 64—Clay County, 67—Clinton County, 68—Dade County, 68—DeKalb County, 69—Gentry County, 69—Hickory County, 69—Holt County, 69—Henry County, 69—Jackson County, 69—Johnson County, 72—Lafayette County, 73—Nodaway County, 73—Newton County, 73—Pettis County, 73—Platte County, 73—Ray County, 74—Saint Clair County, 75—Vernon County, 76—Condition of things in other States, 76—Kansas, 76—Nebraska, 79—Iowa, 81—Minnesota, 81—Colorado, 84—Dakota, 85—Montana, 87—Wyoming, 88—Texas, 88—Indian Territory, 88—Manitoba, 89—Damage done in Missouri, 89—Destitution in Missouri, 91—Address of Relief Committee from Saint Louis Merchants' Exchange, 93—Cases of starvation, 94—The Governor's proclamation, 95—The locusts not a divine visitation, 97—Natural history; Mode of molting illustrated, 98—Habits of the unfledged young, 100—Directions in which the young travel, 101—Rate at which they travel, 102—They reached but a few miles east of where they hatched, 102—Not led by "Kings" or "Queens," 103—The species taken for such, illustrated, 103, 104—The exodus in 1875, 104—Time of leaving of the winged insects, 104—Direction taken by the winged insects, 105—Destination of the departing swarms, 106—Native home of the species, 109—Views previously expressed confirmed, 110—Conditions of migration, 112—Conditions which prevent the permanent settlement of the species in Missouri, 113—Modification of the species by climatic conditions, 114, 155—Definition of the species, 114—How distinguished in all stages from species most nearly allied, 117—Experience in spring of 1875, 118—Contrast in summer and fall, 119—No evil without some compensating good, 120—Injury to fruit and fruit trees, 121—Food plants, 121—Only one kind of plant not touched under all circumstances, 121—Changes that followed the locusts, 121—The widespread appearance of a new grass, ordinarily unnoticed, 122—Appearance of large Worms, 123—The Locusts did not return in the fall, 124—Natural enemies, 124—Remedies against the unfledged insects, 125—Artificial means of destroying the eggs, 125—Various means of destroying the unfledged young, 126—They are within man's control, 126,—The proper ditch to make, 128—Machines used in Colorado, 129—Best means of protecting fruit trees, 130—How to avert locust injuries, 131—Pre-

The Rocky Mountain Locust—Continued.

vention, 131 — Legislation, both national and local, 132 — Bills before the Forty-fourth Congress, 133 — Need of a National Entomological Commission, 133 — The bounties offered in Minnesota, 138 — The requisites of a good bounty law, 133, 139 — How a bounty law would work, 140 — Suggestions, 140 — Lessons of year, 142 — Locusts as food for man, 143 — They have been used from time immemorial, and are used extensively at the present day, 145 — The Rocky Mountain species quite palatable, 146 — Mode of preparation, 147 — False opinions and predictions, 148 — Unnecessary alarm caused by other species, 148 — Injuries of native species in 1875, 150 — Locust flights in Illinois in 1875, 151 — They were composed of local species, 152, 153 — Explanation of these flights, 154 — Locust prospects in 1876, 155 — No danger from them in Missouri, 156.

The Grape Phylloxera

157

The injuries not great in Missouri in 1875, 157 — Completion of its natural history, 157 — Where the winged female lays her eggs, 157, 161 — The sexed individuals illustrated, 158 — Description of the true female, 159 — Description of the impregnated egg, 159, 162 — Practical considerations growing out of these latest discoveries, 163 — Decortication of the bark to destroy the impregnated egg, 163 — The insect may be imported from one country to another on cuttings as well as rooted plants, 163 — Best time to attack the root-lice, 163 — Phylloxera ravages in California, 163 — Great destruction around Sonoma, 164 — Need of action by the State authorities, 164 — Occurrence of Phylloxera in the Southern States, 164 — Report of Committee appointed by the American Pomological Society, 165 — Its occurrence in Georgia, 166, 167 — American Grapes in Europe, 167 — Large demand for our vines, 167 — The American vines flourishing in Southern France where the European varieties perish, 167 — The orders for some varieties exceeded the supply, 168 — Probable future demand, 168.

INNOXIOUS INSECTS.**The Yucca Borer**

169

The only North American Butterfly whose larva has the boring habit, 169 — The arbitrary nature of classificatory divisions, 170 — Butterflies and Moths not easily separated, 170 — Biological history of the species, 171 — Illustrations of all states, 171, 172 — Habits of the larva, 171, 172, 181 — Mode of pupation, 172, 180 — Flight of the imago, 173, 181 — Position of wings when the imago rests or walks, 173 — Bibliographical notes, 173 — Detailed descriptions of the different states, 174, 175, 181 — Structural characters illustrated, 175 — Affinities of the species, 176 — It is a true butterfly, belonging to the Hesperians, 178 — Characters of the Castnians contrasted with those of Hesperians, 176, 177, 178 — In classification it is better to widen than restrict in the higher groups, 179 — Enemies of the Yucca Borer, 179 — Concluding remarks, 179 — Unsafe to describe species from mere drawings, 179.

NOXIOUS INSECTS—Continued.**Supplementary Notes on the Army Worm**

182

Completion of its natural history, 182 — Oviposition of the Moth described, 183 — Eggs described, 183 — Conclusions previously arrived at verified, 184 — Description of the different larval stages, 184.

REPORT IX.

[Published March, 1877.]

Page.

Preface	III
Table of Contents	V

NOXIOUS INSECTS.

Currant and Gooseberry Worms	1
There are several species having different habits, 1—Three which may be destroyed by similar methods, 1—Botanical details as to the Currant and Gooseberry, 2.	
The Gooseberry Span-worm	3
Its natural history, 3—Most destructive gooseberry insect in Missouri, 3—Generic nomenclature, 3—Characters of the moth, 4—Description of the egg, 4—Where the eggs are laid, 4—The insect single-brooded, 5—How it spreads, 5—A native species, 5—Its past history, 5—It prefers the Gooseberry to the Currant, 6—The moth is closely imitated by one which greatly differs structurally, 6—Parasites, 6—Remedies, 7—Other currant Span-worms, 7.	
The Imported Currant Worm	7
Belongs to the "False-caterpillars", 7—The different specific names it has received, 7—An imported species, 8—Its introduction and spread, 8—Independently imported at several eastern points, 9—Its natural history, 9—How the eggs are laid, 10—Nature and habits of the Worm, 11—Characters of the parent flies, 12—Preventive measures, 13—Remedies, 13—White hellebore the best, 13—How best used, 14, 15—The worm is not poisonous, 16—Natural enemies, 17—It furnishes a forcible example of Arrhenotoky or the power of producing male offspring without impregnation, 18—Results of Parthenogenesis in different insects, 18—It also furnishes an interesting instance of Defunctionation of special parts, 19—The saw of the female imperfect, compared with others, 20—Evolutionary bearings of this fact, 21—Descriptive, 21—Variation in the antennæ and wing veins, 22.	
The Native Currant Worm	23
Wherein it differs from the imported species, 23—Its habits, 24—Where the eggs are laid, 25—How the winter is passed, 25—Its occurrence in Missouri, 26—Remedies, 26—Descriptive, 26.	
The Strawberry Worm	27
Also a False-caterpillar, 27—It has a wide range, 27—How the eggs are deposited, 28—Character and habits of the Worm, 28—Remedies, 28—Descriptive, 28.	
Abbot's White Pine Worm	29
Destructive power of the insects of its genus in Germany, 29—Evergreens which it prefers, 30—Habits and characters of the Worm, 30—Variation in the antennæ, 30—Characters of the perfect flies, 30, 31—How the eggs are laid, 31—Natural enemies, 31—Remedies, 32—Descriptive, 32.	
LeConte's Pine Worm	32
A more general feeder than Abbot's species, 32—The close resemblance of the Worms, 33—How they differ, 33—Descriptive, 33—Other species of the genus, 34.	
The Colorado Potato-beetle	34
Injury in the West in 1876, 34—Spread of the insect during the year, 34, 35—Its great abundance on the Atlantic coast, 35—Rate at which it traveled since 1859, 37—An average of 88 miles a year, 37—How it	

	Page.
The Colorado Potato-beetle—Continued.	
traveled, 37; principally in the beetle state, and greatly assisted by man, 37—Its migrating habit, 38—Area invaded by it nearly 1,500,000 square miles, 38—Causes which limit its spread, 38—Will it reach the Pacific slope?, 39—How it affected the price of potatoes, 39—The modification it has undergone, 40—A mite parasite added to its natural enemies, 41—Its introduction to Europe, 42—A living specimen found last summer in the Bremen dock yards, 42—Could it live and multiply in Europe?, 43—Action taken by European governments to prevent its introduction, 44—Consideration of the Kearney "Potato Pest Poison", 45.	
The Army Worm.....	47
Further notes and experiments thereon, 47—Two generations produced annually at Saint-Louis, and a probable third generation, exceptionally, 48—Summary of its natural history, 49.	
The Wheat-head Army-worm	50
A new enemy to wheat, 50—First complaint of it in the East, 51—First appearance in Kansas, 51—Habits and natural history, 52—The egg differs from that of the Army Worm, 53—Wherein the worm is distinguished from its destructive congener, 54—Two broods each year, 54—Natural enemies, 54—Remedies, 55—Descriptive, 55.	
The Rocky Mountain Locust.....	57
It continues to interest the people of the West, 57—Previous opinions justified, 57—The invasion of 1876, 59—Few in British America, 59—Condition of things in Montana, 59—In Wyoming, 59—In Dakota, 59—In Minnesota, 60; locusts and alkali soil, 61; good done by Governor Pillsbury, of Minnesota, 61—In Colorado, 62—In Iowa, 63—In Nebraska, 64—In Kansas, 65—In Missouri, 66—Flights in opposite directions at the same time, 66—Counties in Missouri that were overrun, 67—Red-legged Locust troublesome in East Missouri, 68—Detailed reports from counties in Missouri, 68—Andrew County, 68—Atchison County, 68—Barry County, 68—Barton County, 69—Bates County, 69—Benton County, 69—Buchanan County, 69—Cass County, 69—Cedar County, 70—Caldwell County, 70—Clay County, 70—Dade County, 70—DeKalb County, 70—Gentry County, 70—Greene County, 71—Harrison County, 71—Henry County, 71—Hickory County, 71—Holt County, 71—Jasper County, 72—Jackson County, 73—Johnson County, 73—Lafayette County, 73—Lawrence County, 73—McDonald County, 74—Newton County, 74—Nodaway County, 74—Pettis County, 74—Platte County, 74—Polk County, 75—Ray County, 75—Saint Clair County, 75—Vernon County, 75—In Indian Territory, 76—In Texas, 76—In Arkansas, 76—Destination of the departing swarms of 1875, 77—They reached into British America, 78—Source of the swarms of 1876, 79—Eastern line reached, 80—Rate at which the insects spread, 80—Direction of flight, 81—Influence of wind in determining the course of Locust swarms, 81—Locust flights east of the Mississippi, 81—Geographical range of species, 82—Causes which limit the spread of the Rocky Mountain Locust, 83—Flights of <i>Acridium Americanum</i> , 84—Does the female of the Rocky Mountain Locust lay more than one egg-mass, 85—How the eggs are laid, 86—Philosophy of the egg-mass, 87—How the young locust escapes from the egg, 88—How it escapes from the ground, 90—Additional natural enemies, 91—Animals which destroy the eggs, 91—The <i>Anthomyia</i> Egg-parasite, 92—The Common Flesh-fly, 95—Other undetermined enemies of the eggs, 96—Insects which destroy the active locusts, 98—Experi-	

The Rocky Mountain Locust—Continued.

ments with the eggs and conclusions therefrom, 99—Experiments to test the effects of alternately freezing and thawing, 99—Experiments to test the influence of moisture upon the eggs, 104—Experiments to test the effects of burying at different depths and of pressing the soil, 104—Experiments to test the effects of exposure to the free air, 104—The Omaha Conference, 106—Remedies and suggestions, 108—Destruction of the young or unfledged locusts, 108—Protection of fruit trees, 110—Legislation, 111—Act passed by the Missouri legislature, 111—Acts passed by the Kansas legislature, 112—Act providing for the destruction of locusts in Minnesota, 114—Area in which eggs were laid, 116—Condition of eggs, 117—Temperature of the winter of 1876-'77, 120—Prospects for 1877, 121.

INNOXIOUS INSECTS.

The Hellgrammite	125
Its curious egg-mass described, 126—Resembling bird-dung at a distance, 126—Where laid, 127—The Egg-burster, 127—Characters and habits of the newly hatched larva, 127—Difficulty of rearing it in still water, 128—The eggs that have been hitherto mistaken for those of <i>Corydalus</i> , 128—They are probably those of <i>Belostoma grandis</i> , 128.	
The Yucca Borer	129
It is single-brooded, 129—Will thrive in the latitude of Saint Louis, 129—The larva molts quite often, 129.	

CORRECTIONS.

A list of errata is given for each volume, and they are here reproduced with such additional ones as were previously omitted. Where foreign terms were not properly accentuated in the Reports, it was often due to the imperfect "plant" possessed by the State printer. In counting lines the running page title is omitted.

REPORT I.

- Page 8, line 21, *for being read were.*
Page 10, line 1, *for Figure 3,³ read Figure 3,².*
Page 12, line 20, *for last read 1866.*
Page 12, line 3 from bottom, *after February add (1867).*
Page 12, line 13 from bottom, *for verter read venter.*
Page 14, line 24, *for hermaphrodite read agamic.*
Page 14, line 32, *for females read males.*
Page 15, line 10 from bottom, *for muscle-shaped read mussel-shaped.*
Page 22, line 2 from bottom, *for pupas read pupæ.*
Page 30, note, *for F. read T.*
Page 31, line 15, *for 37° read 38°.*
Page 32, line 4, *for Kreitz read Kreutz.*
Page 32, line 14 from bottom, *for III read V.*
Page 32, line 7 from bottom, *for XIII read VIII.*
Page 38, line 5, *for Tredeim read Tredecim.*
Page 47, line 16, *for far read for.*
Page 50, line 7, *for none the less read no more.*
Page 53, line 28, *for laid read lain.*
Page 54, line 4 from bottom, *for hatch read are deposited.*
Page 56, lines 5 and 12, *for to read at.*
Page 58, line 15 from bottom, *for Aspidiglossa read Aspidoglossa.*
Page 64, line 26, *omit again.*
Page 67, line 11 from bottom, *for class read branch.*
Page 76, line 48, *for Climbing Rustic read Climbing Cut-worm Moth.*
Page 78, line 46, *for unipunctata read unipuncta.*
Page 86, line 21, and wherever they occur, *for Guénée read Guenée; and for Guén. read Guen.*
Page 87, line 11 from bottom, *for F. read T.*
Page 96, note, line 4, *for West. read Wesm.*
Page 112, line 3, *for abbreviated read abbreviated.*
Page 114, line 1, after "insect" read (*Stiretrus fimbriatus*, Say).
Page 120, line 30, after "Cottonwood" read (*Pemphigus vagabundus*, Walsh).
Page 123, last line, *for eriosoma read eriosomatis.*
Page 132, line 16, *for ampelopsis read ampelopsidis.*
Page 133, in heading, *for Codling read Berry Moth.*
Page 133, line 24 from bottom, *for preceding insect read Grape Curculio.*
Page 134, line 3 from bottom, *for Part V read Part VI.*

- Page 142, under the heading, *add* (LEPIDOPTERA TORTRICIDÆ).
 Page 150, line 26, for THYRIDOPTERYX read THYRIDOPTERIGIS.
 Page 150, line 37, for ferruginous read ferruginus.
 Page 154, in the heading, for *zeas* read *zeæ*.
 Page 155, line 13, for ZEAS read ZEÆ.
 Page 161, line 38, for Trallien read Trallian.
 Page 166, under heading, *add* (LEPIDOPTERA, PYRALIDÆ).
 Page 171, line 3 from bottom, for transformation read transformations.
 Page 173, line 3 from bottom, for it read the more liquid parts.
 Page 174, line 3 from bottom, for *Solidaga* read *Solidago*.
 Page 175, line 32, *add* front before wing.
 Page 176, line 21, for through read into.
 Page 177, line 26, *strike out* in.
 Page 177, line 13, after *coæ* read *trochanters*.
 Page 178, lines 2 and 3, for GELECHIA read GELECHLE.
 Page 179, line 32, for assimilating read assimilating.
 Page 179, in heading and line 12, for CHICKWEED read KNOTWEED.
 Page 179, lines 12, 13, for (*Stellaria media*) read (*Polygonum aviculare*).
 Page 180, line 7, for *Cersium lanceolata* read *Cirsium lanceolatum*.

REPORT II.

- Page 8, line 14 from bottom, for I have read has been.
 Page 8, line 13, from bottom, before on read largely from Mr. Walsh's previous writings.
 Page 13, line 25, for cupable read culpable.
 Page 16, line 13, for lava read larva.
 Page 23, line 6 from bottom, for hole read holes.
 Page 32, line 17, for insect read insects.
 Page 35, line 24, for *Corimelæna* read *Corimelæna*.
 Page 40, line 23, for *Ophinsa* read *Ophiusa*.
 Page 41, line 25, for *Laphrygma* read *Laphygma*.
 Page 50, line 5 from bottom, for *leuca[i]æ* read *leucan[i]æ*.
 Page 53, line 12, for *perpulcra* read *perpulchra*.
 Page 56, line 7 from bottom, for *Salanum* read *Solanum*.
 Page 58, line 19, for *copaliua* read *copallina*.
 Page 59, line 9 from bottom, for variegated read variegated.
 Page 76, line 4 from bottom, for I read V.
 Page 76, line 5 from bottom, for *Daphni* read *Daphne*.
 Page 82, line 25, for one read our.
 Page 92, line 3, for 125-131 read 129-131.
 Page 107, line 12, for *Naturalista* read *Naturaliste*.
 Page 111, line 34, for *crysalis* read *chrysalis*.
 Page 116, line 4 from bottom, for month read molt.
 Page 118, line 2, for carved read curved.

REPORT III.

- Page 6, line 3 from bottom, for *Rosa* read *Rose*; and for *rosa* read *rosæ*.
 Page 7, line 31, for *Hyleæctus* read *Hylecætus*.
 Page 25, line 8 from bottom, for finely read finally.
 Page 28, line 3 from bottom, for Holmgren's read Holmgren's.
 Page 30, line 16, for the read the.
 Page 30, line 16, for characterize read distinguish.
 Page 47, line 3, for Feunde read Feinde.
 Page 55, line 50, for that read than.
 Page 57, line 18 from bottom, add e before the first h.
 Page 58, line 3 from bottom, for *formudolosus* read *formidolosus*.

- Page 64, line 19, for *Bignonio* read *Bignonia*.
 Page 78, note, for I read II.
 Page 95, line 26, for *belongs* read *belonging*.
 Page 117, line 5 from bottom, for *Harr.* read *Fabr.*
 Page 123, last line, for *an* read *and*.
 Page 129, lines 12 and 17, for *Colosoma* and *Calosoma*.
 Page 131, line 13 from bottom, for *fauns* read *fauna*.
 Page 135, line 33, for *dints* read *dents*; and line 21, for *a* read *b*.
 Page 136, line 22, for *Guenée* read *Guenée*.
 Page 136, line 33, for *Furtsenthum* Waldeck read *Fllrstenthum* Waldeck.
 Page 145, line 35, *strike out second* the.
 Page 146, line 24, *add s* to transformation.
 Page 150, line 14, at end, *add* from *an*.
 Page 151, line 12, for *Cnythia* read *Cynthia*.
 Page 166, line 16 from bottom, *strike out first* comma.
 Page 166, line 6 from bottom, for *phalangea* read *phalanga*.
 Page 169, line 33, for *first i* read *e*.
 Page 170, line 10, for *Nnaural* read *natural*.

REPORT IV.

- Page 6, first verse, for *grow* read *grows*.
 Page 19, line 8, for 5 read 6.
 Page 20, last line but one, for *R* read *U*.
 Page 22, last line but one, for *Aleochoa* read *Aleochara*.
 Page 40, line 9 from bottom, for *ocular* read *ocular*.
 Page 41, line 59, for *Vt.* read *Ct*.
 Page 41, line 15 from bottom, after "*Larva*" read *Length 0.5 inch*.
 Page 42, line 5, *add a comma* after *Lepidoptera*.
 Page 43, line 6 from bottom, for *claud* read *cloud*.
 Page 46, line 29, for *edgae* read *edge*.
 Page 46, line under heading, *add a comma* after *Lepidoptera*.
 Page 47, line 30, for *rhomboidally* read *trapezoidally*.
 Page 53, line 25, and page 54, line 27, for *basillare* read *basilare*.
 Page 53, *strike out all after* for many in the note.
 Page 59, line 10 from bottom, *add winged before* female.
 Page 67, line 4 from bottom, for *Cordifolia* read *Riparia*.
 Page 68, line 2 from bottom, for *Oid* read *Oil*.
 Page 75, third line in heading, *add a comma* after *Lepidoptera*.
 Page 103, third line of note, for *insest* read *insert*.
 Page 105, line 8 from bottom, for *chrysallis* read *chrysalis*.
 Page 110, line 3, for *CHAL SIS* read *CHALCIS*.
 Page 110, line 29, for *extramatis* read *extrematis*.
 Page 112, in the heading, for *Hüb n* read *Drury*.
 Page 132, line 19, for *Chesnut* read *Chestnut*.
 Page 137, line 1, for *Pernyi Silkworm* read *Perny Silkworm*.
 Page 137, under fig. 60, for *Pernyi* read *Perny*.

REPORT V.

- Page 7, line 22, for *stage* read *state*.
 Page 7, second line from bottom, *strike out second* the.
 Page 8, explanation of Fig. 1, first line, for *and* read *the*.
 Page 9, under Fig. 2, for *BEMBEX FASCIATA* read *VESPA MACULATA*.
 Page 9, line 11, for *last* and *read* with the.
 Page 11, line 9 from bottom, after *worm* *add* moth.
 Page 11, line 3, from bottom, for *four* read *eight*.
 Page 12, line 24, for *ερεποις* read *ερεπος*.

- Page 12, Fig. 5, for *EUSCHISTES* read *EUSCHISTUS*.
 Page 13, line 3 from bottom, for *larvæ* are read *larva* is.
 Page 14, under Fig. 8, for *CE DIPODA DIFFERENTIALIS* read *CALOPTENUS DIFFERENTIALIS*.
 Page 18, line 10 from bottom, for *pollenation* read *pollination*.
 Page 19, line 30, for *Lymexilon* read *Lymexylon*.
 Page 21, line 8 from bottom, for *Townsend* read *Townend*.
 Page 24, line 13, for *ærial* read *aërial*.
 Page 33, in Fig. 15, for *cloroform* read *chloroform*.
 Page 43, line 6 from bottom, after or add in.
 Page 51, line 17, for *J. S* read *S. J.*
 Page 56, line 24, for *how* read *that*.
 Page 52, line 21, for *peteolaris* read *petiolaris*.
 Page 58, line 16 from bottom, for *decrepid* read *decrepit*.
 Page 61, line 18, for *hypertrophized* read *hypertrophied*.
 Page 66, line 13, for *Cordifolio* read *Cordifolia*.
 Page 67, line 27, for *with* read *to*.
 Page 67, line 28, after and add to offer.
 Page 83, line 13 from bottom, for *who* read *as*.
 Page 85, line 17 from bottom, after *fecundation* add either the.
 Page 85, line 18 from bottom, strike out either and after *female* add would.
 Page 86, line 2 from bottom, for *and* read *und*.
 Page 90, line 17, for *had* read *has*.
 Page 100, last line, add a comma before *say*.
 Page 101, line 10, for *nole* read *noli*.
 Page 103, line 9, for *Caryæ* read *caryæ*.
 Page 113, line 40, for 19 read 41.
 Page 115, for *exerted* read *exserted*.
 Page 120, line 25, for *regulary* read *regularly*.
 Page 126, line 4 in note, for *querciti* read *quercetti*.
 Page 126, line 5 in note, for *pithisium* read *pithecium*.
 Page 129, line 14, omit *color* of the.
 Page 139, for *Papineau* read *Popenoe*.
 Pages 140 and 141, wherever *Belvosia* occurs read *Belvoisia*.
 Page 156, line 6, for *consumes* read *has consumed*.

REPORT VI

- Page 8, last line, for 1874 read 1873.
 Page 12, line 13, for *Sisimbrium* read *Sisymbrium*.
 Page 12, line 25, for *osciamus* read *osoyamus*.
 Page 12, lines 13, 14, for *Polygonum* read *Polygonum*.
 Page 27, line 2 from bottom, for *pecorus* read *pecoris*.
 Page 27, line 15 from bottom, for *vireus* read *virens*.
 Page 28, last line, for XV read XVI.
 Page 35, line 3, for *three* read *four*.
 Page 37, line 16, for *first* by read *be*.
 Page 42, line 11, for *the* read *certain*.
 Page 43, line 26, strike out *to be presently treated of*.
 Page 47, remove "Telegraph" from "Summer grape" § to that of "Northern Fox."
 Page 51, line 7 from bottom, for *insidious* read *insidious*.
 Page 53, line 18, for *Maguin* read *Mégnin*.
 Page 82, line 5 from bottom, for *New* read *West*.
 Page 87, line 3 from bottom, for *Bignonio* read *Bignonia*.
 Page 92, line 6, for *Callimorpa* read *Callimorpha*.
 Page 94, line 14 from bottom, for *point* read *joint*.
 Page 100, line 31, omit comma after *lardarius*.

- Page 108, line 28, *for orage read orange.*
 Page 111, line 6, *for perspicillata read tripunctata.*
 Page 118, last line, *for Phytopoga read Phytophaga.*
 Page 136, line 15, *for Rosel von Rösenhof read Rüssel von Rosenhof.*
 Page 141, line 9, *after found add that.*
 Page 150, line 9, *for pictures of read imprints on.*
 Page 154, line 6, *strike out t.*
 Page 154, line 16, *for it is read they are.*
 Page 156, line 8, *after and add more.*
 Page 162, line 10, *for elytram read elytrum.*

REPORT VII.

- Page IV, line 9, *for contemptibly read contemptuously.*
 Page 1, line 10, *after and read invaded the.*
 Page 5, line 16, *for State read state.*
 Page 7, line 7, *for calubrine read colubrine.*
 Page 11, line 32, *for stoma read stomata.*
 Page 11, line 33, *for dilutent read diluent.*
 Page 11, line 37, *for J read S.*
 Page 12, line 13, *for W. K read R. C.*
 Page 17, last line, *for Dep. de l'Hérault read Dép. de l'Hérault.*
 Page 21, line 14 from bottom, *for LENCOPTERUS read LEUCOPTERUS.*
 Page 39, under Fig. 6, *for TTIM read TRIM.*
 Page 52, line 14, *for McWallie read McNallie.*
 Page 52, line 46, *for Princeton read Purinton.*
 Page 75, line 32, *for breed read bred.*
 Page 80, line 7 from bottom, *add a comma before and after pometaria.*
 Page 81, last line, *for nidi read nidus.*
 Page 94, in the sub-head, *for GALL-INHABITING read ROOT-INHABITING.*
 Page 99, line 7, in note, *for nerves read tracheæ.*
 Page 108, line 17, *for two read too.*
 Page 117, line 15, *for V read IV.*
 Page 118, line 17 from bottom, *for hight read height.*
 Page 147, line 20, *for 1873 read 1866.*
 Page 162, line 20, *for larva read lava.*

REPORT VIII.

- Page III, line 13 from bottom, *add 1 before the 3.*
 Page 7, line 26, *for copper read soda.*
 Page 22, in notes, *transpose the " and t.*
 Page 34, line 6, *for tulidtes read tuérites.*
 Page 34, line 11, *for three-hundredths read two-hundredths.*
 Page 37, under Fig. 23, *for exerted read exerted.*
 Page 38, line 6, *for glass read grass.*
 Page 52, line 1 in note, *for Dolichonyx read Dolichonyx, and for orizivora read oryzivora.*
 Page 53, line 32, *for veridascens read viridascens.*
 Page 98, second line, in explanation of Fig., *for e read c and for c read e.*
 Page 100, line 2, *after they add are still imperceptible; in the third stage (after second molt) they.*
 Page 100, line 4, *for third read fourth, and for second read third.*
 Page 100, line 7, *for fourth read fifth, and for third read fourth.*
 Page 100, line 8, *for fourth read fifth and for fifth read sixth.*
 Page 114, line 7 from bottom, *for distingulsh read distinguish.*

- Page 115, line 5, *after histories add a comma.*
 Page 115, line 5 from bottom, for *Pesotettix* read *Pezotettix*.
 Page 121, line 18, *after limbs add and.*
 Page 149, under Fig. 46, for *larva* read *pupa*.
 Page 150, line 10, for *gran* read *granu*.
 Page 154, line 4 from bottom, for *sheli* read *shell*.

REPORT IX.

- Page 6, line 26, insert after "moth" (*Euphanessa mendica*, Walk.).
 Page 15, line 3, for *entite* read *entire*.
 Page 29, in explanation of cut, for *Abbott's* read *Abbot's*.
 Page 50, explanation of cut, for *e* read *c*.
 Page 50, line 3 from bottom, for *Hubner* read *Hübner*.
 Page 54, last line, in place of the comma, *write is*.
 Page 55, line 1, for *the other* read *the second*.
 Page 55, line 9 from bottom, for *m. m* read *mm*.
 Page 55, line 7 from bottom, *strike out the on*.
 Page 56, line 1, for *m. m* read *mm*.
 Page 56, line 2, for *the last* and read *anal*.
 Page 56, line 32, commence a new ¶ with "*Chrysalis*" and italicize it.
 Page 57, in the heading for *Spretus* read *spretus*.
 Page 58, line 14, *strike out have*.
 Page 87, *strike out the g* in line 17 and also in figure.
 Page 89, line 13, *strike out the i* after *embryon*.
 Page 90, last line, for *ambion* read *amnion*.
 Page 98, line 11 from bottom, for *Compoplex* read *Campoplex*.
 Page 98, line 6, *add a comma before De Geer*.
 Page 98, note *, for *Bastardii* read *Bastardi*.
 Page 98, under Fig. 23, for *BASTARDII* read *BASTARDI*.

NOTES AND ADDITIONS.

Under this head it is not my purpose to publish the many additional notes of observations which have been made by myself and others on the various insects treated of in the reports ; but rather to indicate a few of the more important facts, especially such as are unpublished and bear on life-histories left incomplete. As, in preparing the reports, the older and better known generic nomenclature was almost uniformly employed, it is thought advisable to indicate in this bulletin the more recent nomenclature, and this is accordingly done either in these "Notes" or in connection with the reproduced "Descriptions of New Species" which follow :

HYMENOPTERA.

STIZUS GRANDIS Say (Rep. I, p. 27, Fig. 12)—This has been shown by Mr. W. H. Patton (Bull. U. S. Geol.-Geog. Survey, vol. V, p. 342) to be only a variety of *speciosus* Drury, which is the type of the genus *Sphæctus* Dahlb.

CRYPTUS EXTREMATIS Cress. (Rep. IV, p. 111)—The questions in regard to the character of *C. samiae* Pack. have been settled by Dr. Hagen from an examination of the types (Bull. Buff. Soc. Nat. Sci., II, 206; 1875) confirming the conclusion which I came to. In Bulletin No. 3 of the Commission (p. 47) I have suggested that *extrematis* should sink as a synonym of *samiae*, because two species (one of which is *nunciatus*) were combined under it in the original description.

MICROGASTER MILITARIS Walsh (Rep. I, p. 89 and subsequently)—This is an *Apanteles** (See my Notes on N. A. Microgasters, etc. (Extr. from Trans. St. Louis Ac. Sc. IV), p. 19.)

ANTIGASTER MIRABILIS Walsh (Rep. VI, p. 162)—Mr. L. O. Howard has shown (Can. Ent. October, 1880, p. 209, and February, 1881, p. 31) that the habit of rolling back is not uncommon in the *Eupelmides*, and that *Antigaster* cannot well be separated from *Eupelmus* as at present understood.

COLEOPTERA.

CARABID LARVÆ (Rep. IX, p. 97)—The second larva mentioned on this page was subsequently reared by me to the perfect state and proved to be *Amara obesa* Say. It will be found figured and described in the First Report of the Commission (p. 290).

LEBIA GRANDIS, Hentz (Rep. III, p. 100)—This belongs to Chaudoir's genus *Loxopseza*.

LEBIA ATRIVENTRIS Say (Rep. VIII, p. 3)—Belongs to Chaudoir's genus *Loxopseza*.

HIPPODAMIA MACULATA, DeGeer (Rep. I, p. 112 and subsequently)—Now referred to Mulsant's genus *Megilla*. It does not appear that this species occurs also in Europe as stated in the text.

COCCINELLA MUNDA Say (Rep. II, p. 25)—This is now considered synonymous with *Cycloneda sanguinea* Linn.

COCCINELLA PICTA Randall (Rep. V, p. 101)—Now known as *Harmonia picta*.

MYSIA 15-PUNCTATA, Oliv. (Rep. IV, p. 18)—This has been referred to the genus *Anatis*, Mulsant.

LACHNOSTERA QUERCINA, Knoch. (Rep. I, p. 156)—This is synonymous with *fusca* Fröhlich, which has priority. The fungus affecting it (p. 158 and Rep. 6, p. 125) is *Cordyceps ravenelli* Berkeley. (See *American Entomologist*, III, p. 139.)

CHAULIOGNATHUS PENNSYLVANICUS, De Geer (Rep. I, p. 57 and subsequently)—This is now known as *Ch. americanus* Forst., the latter name having priority. For an account of the eggs and young larvæ, see Second Report of the Commission, p. 261.

SAPERDA BIVITTATA Say (Rep. I, p. 42)—This is now admitted to be a synonym of *candida* Fabr. For a correct description of the eggs and mode of oviposition, see an article by me in *New York Weekly Tribune*, Feb. 20, 1878.

BRUCHUS PISI Linn. (Rep. III, p. 44)—This name of the 12th edition of Linnaeus's "Systema Naturæ" gives way in modern catalogues to *pisorum* L. of the 10th edition.

FIDIA VITICIDA Walsh (Rep. I, p. 32)—This species is not mentioned by Crotch in his "Materials for the Study of the Phytophaga of the U. S." (Proc. Ac. Nat. Sc. Phil., 1873), but his *Fidia murina* (l. c. p. 33) is undoubtedly synonymous with Walsh's *viticida*, the latter name having priority by several years. In Crotch's "Check list" this species is also omitted, but the *Fidia vitis* Walsh in the "Omissions" to that list (p. 127) is probably meant for *viticida*.

HALTICA CHALYBEA, Illiger (Rep. III, p. 79)—This belongs to the genus *Graptodera* Chev.

HALTICA CUCUMERIS Harris (Rep. I, p. 101)—This is now referred to the genus *Epitrix*, Foudras.

PHYSONOTA QUINQUEPUNCTATA Walsh & Riley (Rep. II, p. 59)—This is synonymous with *Ph. unipunctata* (Say), there being no question as to the specific identity of the two, both having been bred by Mr. F. H. Chittenden, of Ithaca, N. Y., from larvæ on a wild sun-flower (*Helianthus*).

CASSIDA NIGRIPES Oliv. (Rep. II, p. 63)—The eggs of this species are much like those of *aurichalcea* (Rep. II, Fig. 31) in size, form and color, though the spine-like appendages break off more easily. They may, however, be distinguished by being larger (1.6mm long without projections), having, in fact, nearly double the bulk, and by the flat posteriorly projecting piece which bears the spine-like appendages being generally greatly developed so as sometimes to extend beyond the apex fully one-third the length of the whole egg. Sometimes this piece divides distinctly into three spines, but in other cases it is quite blunt.

CASSIDA BIVITTATA Say (Rep. II, p. 61)—The eggs of this species are pale and ovoid, just 1mm long, but invariably covered with a yellowish secretion which dries and spreads out each side, and this by a black excrementitious material which gives the egg from above the appearance of an ovoid bit of excrement flattened on the adhering side. The eggs are laid singly or in twos or threes.

CASSIDA AURICHALCEA Fabr. (Rep. II, p. 62)—This is now referred to the genus *Coptocycla* Chev.

CASSIDA PALLIDA Herbst (Rep. II p. 62)—This is now recognized as a synonym of *Coptocycla aurichalcea* (Fabr.).

COPTOCYCLA GUTTATA, Oliv. (Rep. II, p. 63)—The eggs of this species, which I have often since observed, are deposited singly or in twos, threes or fours. They are rather more than 1mm long, of the same general form and character as those of *Cassida bivittata*, but more narrow and elongate. The color is pale yellowish and translucent. The egg is always covered with a viscid fluid which dries to form a transparent covering verging to fulvous or gamboge in color. This covering almost always spreads out on each side of the egg in ray-like ridges, those on each side parallel and slightly oblique, and whenever the egg is single these ridges are remarkably regular and have a neat appearance. There is occasionally on the top of this a varying amount of ex-

crement. The structure of the covering is similar to that found in the egg of *Cassida texana* Cr. (which feeds on *Solanum eleagnifolium*), where, however, the ribs are finer and transverse, and there is no excrementitious covering. The newly hatched larva of *guttata*, like that of the other species is whitish, strongly recalling in general appearance an ordinary mite, the head not being concealed as it subsequently is, the hairs at the tip of the legs being frequently clavate or knobbed, and resembling those on the young of many Coccids. The marginal spines and the anal fork are quite well developed but simpler than in the subsequent larval stages. This newly hatched larva is quite nimble and crawls easily over glass.

DELOYALA CLAYATA, Oliv. (Rep. II, p. 56)—Now referred to the genus *Coptocycla*.

BLISTER-BEETLES (Rep. I, p. 96 ff.)—The larvæ feed on locust eggs. For account of their larval economy see my paper "On the larval Characters and Habits of the Blister-beetles," etc., Trans. Ac. Sc. St. Louis III, p. 544 ff.: also Reports of the Commission I, p. 292 ff.; II, 262 ff. Remarks on synonymy are also there given, but the following may be repeated.

LYTTA CINEREA Fabr. (Rep. I, p. 97)—This is now known as *Macrobasis unicolor* (Kirby).

LYTTA MURINA Lec. (Rep. I, p. 98)—This is a color variety of *Macrobasis unicolor*.

LYTTA MARGINATA Fabr. (Rep. I, p. 98)—This is believed by Horn to be a color-variety of *Epicauta cinerea* (Forst.).

LYTTA ATRATA Fabr. (Rep. I, p. 98)—This is the *Epicauta pensylvanica* (De Geer) of Crotch's List.

ANTHONOMUS PRUNICIDA, Walsh. (Rep. III, p. 39)—Upon this species, which is a synonym of *scutellaris* Lec., Dr. Leconte has since founded the genus *Coccotorus* (Proc. Am. Philos. Soc. vol. XV, 1876, p. 193).

CONOTRACHELUS NENUPHAR, Hbst. (Rep. III, p. 127, note)—The phytophagic variety of this species from Walnut and Butternut has since been characterized by Dr. Leconte as a distinct species, *C. juglandis* (Proc. Am. Philos. Soc. vol. XV, p. 226).

CÆLIODES INÆQUALIS, Say (Rep. I, p. 123)—Dr. Leconte has since founded upon this species the genus *Craponius* (Proc. Am. Philos. Soc. vol. XV, 1876, p. 268). The egg of this snout-beetle is quite large, bright yellow in color and deposited in a cavity half as large as the beetle, though the puncture leading to it is small. The lateral angularities or tubercles of the joints, as described by Walsh, are quite characteristic, and the dorsal view in my figure, given to show them, conveys a somewhat false impression of the larva, which is more or less curved, and has the general characteristics of Curculionid larvæ. The figure is rather more attenuated than it should be. That the beetle hibernates I have since proved beyond question.

BARIDIUS TRINOTATUS Say (Rep. I, p. 93)—Dr. Leconte (Proc. Am. Philos. Soc. XV, 1876, p. 287) has since established for this and two allied species the genus *Trichobaris*.

SPHENOPHORUS ZÆE Walsh (Rep. III, p. 59)—This has been previously described by Mr. Uhler as *S. sculptilis* (Proc. Ac. Phil. VII, 1855, p. 416).

SPHENOPHORUS PULCHELLUS Schöenherr (Rep. III, p. 60)—As intimated in the footnote on the same page, this species is synonymous with Say's *S. 13-punctatus*, for which species and for *Sphenophorus pustulosus* Gyllh. Dr. Leconte has established the genus *Rhodobanus* (Proc. Am. Philos. Soc. vol. XV, 1876, p. 332). I have reared both, and also intermediate forms, from Helianthus in Texas, and Ambrosia in Missouri.

SCOLYTUS CARYÆ Riley (Rep. V, p. 107)—Dr. Leconte (Proc. Am. Phil. Soc. XV, 1876, p. 371) has since decided that *4-spinosus* Say is the ♂ of this species, and Say's name consequently obtains.

LEPIDOPTERA.

PAPILIO PHILENOR Drury (Rep. II, p. 116)—Referred by Scudder to Hübner's genus *Laërtias*. For further notes and description of the egg and young larva, see *Canadian Entomologist*, January, 1881, p. 9, and *American Naturalist*, April, 1881, p. 327.

DANAIS ARCHIPPUS, Fabr. (Rep. III, p. 143)—For further facts respecting the swarming and migrations of this butterfly, see the *American Entomologist* (III, p. 101), and for a fuller and more accurate account of the mode of pupation, see my paper on the "Philosophy of the Pupation of Butterflies and particularly of the Nymphalidæ" (Proc. Am. Ass. Adv. Sc. vol. XXVIII, 1880).

ÆGERIA ACERNI, Clem. (Rep. VI, p. 110)—Mr. D. S. Kellicott has an interesting article in the *Canadian Entomologist* for January, 1881, on the *Ægerians* inhabiting the vicinity of Buffalo, N. Y., in which he states that the chrysalis of this species in his locality does not agree with my description as "unarmed," if that description refers to the dorso-abdominal teeth. A reëxamination of my specimens shows that my statement applies to the absence of these teeth. It is, however, possible that there is some variation in this regard and that the eastern specimens from the Hard maple differ from the western ones from the Soft maple in having the teeth as indicated by Mr. Kellicott.

ARCTIA ISABELLA, Smith (Rep. IV, p. 143)—Referred to *Pyrrharctia* Packard. For further account of larval variation and parasites, see *American Entomologist*, III, p. 134 (June, 1880).

HYPHANTRIA TEXTOR HARR. (Rep. III, 130)—There is no doubt in my mind, from frequent breeding of specimens, that this is synonymous with *cunea* Drury and *punctata* Fitch, which are but varieties, Drury's name having priority.

CALLIMORPHA FULVICOSTA, Clem. (Rep. III, 132)—Grote and Robinson give the synonymy of this species in their "List of Lepidoptera of N. A.," etc., *lecontei* Boisd. having priority. The late Jacob Boll bred all the forms from larvæ feeding on the same species of plant.

SAMIA COLUMBIA Smith (Rep. IV, p. 107)—Mr. Herman Strecker has given a beautiful figure of the male of this species in his "Lepidoptera Rhopaloceres and Heteroceres, etc.," 1875 (Pl. XII, Fig. 3), and Mr. F. B. Caulfield has described and figured the larva (*Canadian Entomologist*, X, p. 41, 1878) showing that it is structurally identical with that of *cecropia* and differs only in the intenser green of the body, in the lateral tubercles and bases of the others being white instead of pale blue and in the upper thoracic tubercles being of a deeper coral-red. It accords more with the *cecropia* larva in the fourth stage. It is placed as a good species in Grote's "List of N. A. Platyptericæ," etc. (Am. Phil. Soc., 1874), but I am still of opinion that it should not be considered a distinct species but simply a well-marked local color-variety worthy of name. There is great variation in color, whether of the larva, cocoon or imago, in *cecropia*.

CALLOSAMIA ANGULIFERA, Walker (Rep. IV, p. 122, note)—This is still considered a good species by systematists. Mr. Jno. Akhurst, of Brooklyn, N. Y., informs me that he finds it rather constant from larvæ which seem to differ in no respect from those of *promethea*, but which feed on the Tulip tree (*Liriodendron tulipifera*), and make the cocoon near the ground without pedicel. I learn from Dr. Packard that Mr. Uhler has bred both it and *promethea* from the same lot of larvæ.

CLISIOCAMPA SYLVATICA HARR. (Rep. III, 121)—This is now referred to *diastria* Hübn., which has priority.

AGROTIS INERMIS HARR. (Rep. I, p. 72)—This is now recognized to be identical with the European *A. saucia* Treitschke.

NOCTUA CLANDESTINA HARR. (Rep. I, p. 79)—An *Agrotis*.

AGROTIS TELIFERA HARR. (Rep. I, p. 80)—This is now recognized as the European *A. ypsilon* Hüfn. = *A. suffusa* (S. V.) = *A. ortonii* Pack.

AGROTIS SUBGOTHICA HARR. (Rep. I, p. 81)—The moth represented under this name at Fig. 29, a, has since been described by Grote as *A. herilis*, and that at Fig. 29, b, has since been described by Lintner as *A. tricosæ*. (Notes on some N. Y. Noctuidæ, Ent. Cont. III in Rep. N. Y. St. Mus. Nat. Hist., 1872, p. 159.)

AGROTIS JACULIFERA Guen. (Rep. I, p. 82)—This is the true *subgothica* of Haw. (See Grote, List of Noctuidæ of N. A., Bulletin Buffalo Soc. Nat. Sc. II, 1874, and Lintner l. c.)

AGROTIS DEVASTATOR, Brace (Rep. I, p. 83)—Grote refers it to *Hadena*.

CELENA RENIGERA Stephens (Rep. I, p. 86)—Referred by Grote to *Hadena*. Specimens in the Fitch collection marked with names (evidently from Walker) *infesta*, *egens*, *defectua*, *subodens* ? and *mucoimaculata* seem to be all synonyms and mere variations.

PRODENIA AUTUMNALIS Riley (Rep. III, p. 116 and subsequently)—As stated in the 8th Report (p. 48) this in the more typical form is recognized as *Laphygma frugiperda*, Sm. & Abb. The variety *obscura*, as Prof. Zeller, who has seen it, informs me is so near the European *exigua* Hübn. that it is not easily distinguished.

PRODENIA COMMELINÆ, Sm. & Abb. (Rep. I, p. 88, and III, p. 113)—Dr. Leon F. Harvey (Bull. Buff. Soc. Nat. Sci., vol. II, pp. 274, 275; 1875) has since proposed specific names for two of the forms hitherto considered to be but varieties of *commelina*. The moth represented at Fig. 48, c, of the Third Report, is named by him *flavimedia*, that at Fig. 48, b, *lineatella*, the true *commelina*, being a larger species. From larvæ with the series of black triangles bordered exteriorly by a yellow line (such as are represented on Plate I, Fig. 12 of Rep. I, and at Fig. 48 a of Rep. III) I have bred the *flavimedia*. But larvæ found on cotton in the Southern States, and differing in having black triangles on the second joint only, and also varying greatly in coloration, have produced the same moth. Abbot's figure of the larva of *commelina* shows the full series of black triangles, but without any yellow exterior line.

GORTYNA NITELA Guen. (Rep. I, p. 92)—I have proved by breeding that *G. nobris* Gn. is but a large, southern form of this species. In the Southern States it is most common in stems of *Ambrosia trifida*, often producing a swelling or pseudo-gall. Both forms are indiscriminately bred with intermediate variations. See an article by Miss E. A. Smith (7th Report on the insects of Illinois, Cyrus Thomas, pp. 112-114) for additional food-plants and the habit of the younger larvæ to infest wheat-stalks, corn, etc. See also Am. Ent. I, p. 252; my "Potato Pests" (Orange, Judd & Co., 1877, p. 91) and *Prairie Farmer*, August 11, 1877. The insect normally pupates in the stem and when infesting thin stalks like those of most cereals and blue-grass (in which it is also found) often of necessity leaves one stalk for another.

ANOMIS XYLINA, Say (Rep. II, p. 37; VI, 17)—This has since been referred by Grote to Hübner's *Aletia argillacea*, which has been generally adopted. See Bulletin 3 of the Commission on the Cotton Worm. While it will doubtless be found convenient in future to separate it from the other species of the genus *Anomis*, and Hübner's generic name may therefore obtain, I must confess, after a careful examination of Hübner's figure of *argillacea*, to grave doubts as to the correctness of Grote's reference thereto of our Cotton-worm Moth (*xylina*, Say). Hübner's figure lacks several of the most constant characteristics of *xylina*. It is fulvo-testaceous shaded with brown, with the under side bright yellow. It lacks the three white specks on primaries and has a dark (orbicular?) spot in place of the outer one. It has a large white circular spot with black annulus in place of the dusky elongate discal spot with its double pupil. The wavy lines are almost black and differ in form; the fringes are unicolorous, and the abdomen is narrower. The figure more nearly represents in fact a species which I have received from Bahia, Brazil, and which differs from *xylina*, though the larva (also quite different) feeds on cotton.

We are all inclined to follow determinations of those who make a specialty of any group, but after due allowance for faulty coloring in Hübner's figure, I am constrained to believe that in this instance Mr. Grote has been in fault.

CANKER-WORMS (Rep. VIII, p. 12)—For additional remarks as to the generic characters of the two Canker-worms, see my paper "On the differences between *Anisopteryx pometaria* Harr. and *Anisopteryx ascularia* W. V., with remarks on the genus *Paleacrista*. (Trans. Ac. Sc. St. Louis, Vol. III, p. 573 ff.)

GALLEREA CEREANA, L. (Rep. I, p. 166)—This is the *mellonella* L. of the 10th edition *Syst. Naturæ*.

PEMPELIA GROSSULARIÆ Packard (Rep. I, p. 140)—The European *Zophodia convolutella* Hübn. (*Phycis grossulariella* Treitschke), which has precisely similar habits, closely resembles this species. In 1871 I compared it with this last in Mr. Stainton's collection and with specimens received from Prof. Zeller and could detect no essential differences. The European specimens are slightly larger, with broader wings and usually clearer, paler gray coloring. Colorational markings are, however, very variable in specimens from both sides of the Atlantic.

P. grossulariæ Packard was subsequently described by Grote as *Dakruma turbatella* (Bull. U. S. Geol.-Geog. Survey, IV, No. 3, p. 702; 1878). *Dakruma* seems to differ from *Zophodia* in nothing but the absence of the basal portion of the subcostal vein and possibly, although this character is not mentioned by Grote, in the recurved palpi. According to the synoptical table given by Heinemann, *grossulariæ* would fall in the genus *Stenoptycha*, distinguished from *Zophodia* by the recurved palpi. We may well question the generic value of this character, for different authors describe it quite differently: thus, Heinemann describes the palpi of *Stenoptycha* and *Homeosoma* as recurved, whereas Grote describes them as porrect in these two genera, if we accept his statement that *Honora* Grote is to be considered a section of *Stenoptycha*: there appears also to be a difference in position in specimens of the same species, according as the palpi are heavily scaled or have lost the scales. From the known individual variation in the venation of these and other moths, especially in the hind wings, we cannot attach any specific, much less any generic, value to the slight difference in the subcostal vein of *Dakruma* noted above. Moreover, authentic specimens of *grossulariæ* do not appear to possess this character of *Dakruma*. I am, therefore, of opinion that a study of sufficient material from both continents will prove the two specifically identical, or at the most that our American insect is a variety, and that *Dakruma* will not obtain. Packard is of this opinion, as in the later editions of his *Guide* the species is called *Myelois convolutella*.

PENTHINA VITIVORANA Packard (Rep. I, p. 133)—This is identical with a European insect having the same habits. It was first described over a century since by Schiffermüller & Denis as *Tortrix botrana*, and has been referred to various genera since, and finally to *Eudemis* Hübn., so that the insect should be known as *Eudemis botrana* (Schiff.). *Conohyllis ambiguella* (Hübn.) has very similar habits in Europe. See Nördlinger's "Die Kleinen Feinde der Landwirtschaft," p 424 ff. It is the *Lobesia botrana* of the later editions of Packard's *Guide*.

EURYPTYCHIA SALIGNEANA Clem. (Rep. II, 134).—This according to Prof. Fernald, who has seen the type, is the same as Clemens's *Hedya scudderiana* (Proc. Acad. Sci. Phila., 1860, p. 358), the description of which is very brief and presumably taken from a female. The genus *Euryptychia* (Proc. Ent. Soc. Phila. V, 140) is founded on the male, which has a broad fold extending to the middle of costa on the primaries and covering up a pencil of yellowish hairs. Zeller subsequently redescribed it as *Pediasca affusana* (Beiträge, etc., pt. III, p. 101 [307]). From a comparison of female specimens I am led to believe that this is the same species that is commonly known in Europe as *Spilonota roborana* Schiff., though in Staudinger and Wocke's Catalogue *cynosbana* Fabr., described in 1875, is given the priority and *agana* Hübn. is placed as a synonym. The obliquity of the edge of the basal dark patch and the details of the ocellated spot upon which species have been separated, I find to be variable.

The insect in Europe is known to feed on the leaf-buds of the rose. I have abundant proof that in this country it is not a gall-maker, but, as was inferred in the Report, an inquiline. I have found its larva feeding upon the flowers as well as amid the terminal leaves of the Golden-rod, and have also found it in other galls. When feeding in the more exposed positions it generally has a carneoous or rosy tint.

ANCHYLOPERA FRAGARIÆ W. & R. (Rep. I, 142)—This has been referred to *Phacopteris comptana* Fröhl., and while the two very closely resemble each other Prof. Fernald informs me that he yet believes *fragariæ* to be distinct.

ETA COMPTA, Clem. (Rep. I, p. 151)—Notwithstanding Mr. Grote doubts the identity of this insect with Cramer's *Phalana punctella*, there is no question in my mind about it, and I entirely agree with Zeller, who makes also the *Tinea pustulella* Fabr. a synonym (Beitr. z. Kenntn. N. A. Nachfalter II, p. 28). It was first described in this country in 1856 by Fitch as *Deiopeia aurea* (3rd Rep. Ins. N. Y., p. 168.) See also "Zygænidæ and Bombycidæ of N. A." by R. H. Stretch, 1872, pp. 159 and 241.

The egg of this insect is one of the most singular Lepidopterous eggs with which I am familiar. I have found it numerous in the South in midsummer. It is 0.9^{mm} long, soft and plastic so as to be variable in form; but when laid (as it often is) on the web which the young larvæ make, where it takes on the more natural form, it is ovoid, somewhat compressed, with frequently a median ridge and one end narrowed and produced into a short neck. The color is cream-yellow and the delicate shell is corrugulate. It is laid singly and generally slightly attached by the broad side to the side of the mid-rib of the tenderest leaves, and its contact (by virtue, doubtless, of some poisonous liquid with which it is laid) causes a well defined swelling of the leaf-vein.

The species is placed among the *Zygænidæ* in Grote and Robinson's *List*, and has evidently more affinities therewith than with the *Teneidæ*.

PRONUBA YUCCASELLA Riley (Rep. V, p. 150 and subsequently)—For further facts regarding this species, see my papers in Trans. St. Louis Ac. Sc. III, p. 568; *American Entomologist* III, pp. 141, 182, 293, and also a paper read before the American Association for the Advancement of Science at Boston, Aug., 1880, and to be published in the Proceedings of the Association for that year.

PTEROPHORUS PERISCELIDACTYLUS (Rep. III, p. 65)—This belongs to the genus *Oxyptilus*, Zeller.

HETEROPTERA.

ARMA SPINOSA Dallas (Rep. II, p. 113 and subsequently)—Now referred to Stål's genus *Podisus*.

EUSCHISTUS PUNCTIPES, Say (Rep. IV, p. 19 and subsequently)—This is now known as *Euschistus variolarius* Beauv., this last having priority over Say's name.

COREUS TRISTIS, De Geer (Rep. I, p. 113 and subsequently)—Belongs to Amyot & Serville's genus *Anasa*.

MICROPUS LEUCOPTERUS, Say (Rep. II, p. 15 and subsequently)—Now referred to Burmeister's genus *Blissus*.

ANTHOCORIS INSIDIOSUS, Say (Rep. II, p. 27 and subsequently)—Belongs to Fieber's genus *Triphleps*.

REDUVIUS RAPTORIUS Say (Rep. I, p. 114)—Belongs to *Sinea*, Amyot & Serv., and is synonymous with *diadema* Fabr.

HARPACTOR CINCTUS Fabr. (Rep. I, p. 114 and subsequently)—Belongs to Stål's genus *Milyas*.

HOMOPTERA.

CICADA SEPTEMDECIM (Rep. I, p. 18)—This orthography, used in the Reports, is grammatically correct, but I find that Linnæus himself wrote *septendecim* (*Systema Naturæ*, Tom I, Pars II, 12th Ed. Stockholm 1767). Fitch used both forms of spelling, but Westwood, Harris and most other authors follow Linnæus, and *septendecim* is, therefore, preferable. As to whether the 17 and 13-year broods should be considered specifically distinct, I am still of the opinion expressed in the First Report that the insects should not be looked upon as distinct species, but that *tredecim* Riley should rather be considered a race, or as Walsh (in a letter to Charles Darwin, which has kindly been shown me by Mr. G. H. Darwin) puts it, an incipient species, to which, for convenience, it is desirable to give a distinctive name. That it may be looked upon as a good species by excellent authority, will be seen by Walsh's discussion of the subject (*American Entomologist* II, p. 335) which I here quote:

What candid entomologist, who has worked much upon any particular order, will not allow that there are certain genera where it is often or almost or quite impossible

to distinguish species by the mere comparison of cabinet specimens of the imago! Løw and Osten Sacken have said this of the genus *Cecidomyia* in Diptera; Osten Sacken of two other Dipterous genera, *Sciara* and *Ceratopogon*; Norton of the genus *Nematus* in Hymenoptera; and Dr. Le Conte lately assured me that, although when he was a young man he thought himself able to discriminate, in the closet, between the different species of *Brachinus* in Coleoptera, he now considered it quite impracticable to do so with any degree of certainty. And yet who doubts the fact of the existence, in North America, of very numerous distinct species of *Cecidomyia*, of *Sciara*, of *Ceratopogon*, of *Nematus*, and of *Brachinus*.

Upon the same principle I strongly incline to believe that the 17-year form of the Periodical Cicada (*C. septemdecim*, Linn.) is a distinct species from the 13-year form (*C. tredecim*, Riley) although it has been impossible for me, on the closest examination of very numerous specimens, to detect any specific difference between these two forms.* It is very true that the 13-year form is confined to the more southerly regions of the United States, while the 17-year form is generally, but not universally, peculiar to the Northern States; whence it has been, with some show of plausibility, inferred that the 13-year form is nothing but the 17-year form accelerated in its metamorphosis by the influence of a hot southern climate. But as these two forms interlock and overlap each other in various localities, and as it frequently happens that particular broods of the two forms come out in the same year, we should certainly expect that, if the two forms belonged to the same species, they would occasionally intercross, whence would arise an intermediate variety having a periodic time of 14, 15 or 16 years. As this does not appear to have taken place, but, on the contrary, there is a pretty sharp dividing line between the habits of the two forms, without any intermediate grades of any consequence, I infer that the internal organization of the two forms must be distinct, although externally, when placed side by side, they are exactly alike. Otherwise, what possible reason could there be for one and the same species to lie underground in the larva state for nearly 17 years in one county, and in the next adjoining county to lie underground in the larva state for scarcely 13 years? I presume that even the most bigoted believer in the old theory of species would allow that, if it can once be proved to his satisfaction that two apparently identical forms are always structurally distinct, whether in their external or in their internal organization, they must necessarily be distinct species.

On the other hand, I firmly believe that many perfectly distinct forms, which at one time passed current, or which even now pass current, as true species, are in reality mere dimorphous forms of one and the same species. We find a good example of this in the dimorphous ♀ *Cynips*, *q. aciculata*, O. S., which has already been treated of at great length. We find another good example of the same thing in *Cicada Cassini* ♂ ♀, Fisher, which is sufficiently distinct from the Periodical Cicada to have been classified as a distinct species, and yet never occurs except in the same year and in the same locality as this last, and what is more extraordinary still, is found not only along with the 17-year form (*C. septemdecim*), but also along with the 13-year form (*C. tredecim*).

Now, if *Cassini* were a distinct species, and not, as I believe it to be, a mere dimorphous form of *C. septemdecim* and *C. tredecim*, the chances are more than a million millions to one against its always coinciding with the two other forms, not only as to the particular locality but as to the particular year of its appearance.

I do not know that any one has heretofore attempted to set at rest, by actual proof, the very general skepticism as to this insect remaining so long underground, on the part of those persons who have given little attention to the subject. I have been able to trace the development from year to year of my *tredecim* brood XVIII in the vicinity of Saint Louis by digging up the larvæ each year from 1868 to 1876, and noting the annual growth. They could always be found within from two to five feet of the surface upon the roots of trees, and had by the 8th year attained the first pupa stage, and I have no doubt but that, at this writing, the true pupæ are nearing the surface of the ground to appear in myriads in the perfect state in May and June of this year.

The fungus affecting this Cicada has since been described by Mr. C. H. Peck as *Massospora cicadina* (31st Rep. N. Y. State Mus. Nat. Hist., pp. 44, 1879).

ERIOSOMA PYRI, Fitch (Rep. I, p. 118) — After comparing specimens in Europe with our American insect, I have no doubt of the specific identity of the two, or of the root-inhabiting and twig-inhabiting forms. The insect should be known, therefore, as *Schizoneura lanigera* (Hausm.). See my remarks in *American Entomologist*, II, 359;

* For an excellent statement of the facts bearing upon this curious question, see a paper by Mr. Riley, the State Entomologist of Missouri, in No. 4 of the *American Entomologist*, and a still more complete one in his First Annual Report.

Rep. 3, p 95, and "Notes on Aphididæ of the U. S." (Hayden's Bull. U. S. Geol. & Geogr. Surv. of Terr., Vol. V, p. 3).

ASPIDIOTUS HARRISII Walsh (Rep. I, p. 7)—This belongs to Costa's genus *Diaspis*, and is apparently the species named *ostreaformis* by Curtis (Gardener's Chronicle, 1843, p. 805).

DIPTERA.

TRUPANEA APIVORA Fitch (Rep. I, p. 168; II, 122)—This has been renamed *Pro-machus Fitchii* by Osten Sacken (Cat. of the described Diptera of N. A. 2nd Ed., 1878, p. 234), the species proving different from *Bastardii* Læw, and Fitch's name being pre-occupied.

BEE-FLY LARVA (Rep. IX, p. 96)—The undetermined larva here illustrated (Fig. 24) has since proved to be that of a *Systoechus*, a genus of Bombyliid flies. For further details and determinations see the Second Report of the Commission (pp. 262-9).

SARCOPHAGA CARNARIA, L. (Rep. IX, p. 95)—The variety *sarracenia* of this species there mentioned is now considered a good species, for reasons stated in Bulletin 3 of the Commission (pp. 39, 40, note).

EXORISTA LEUCANÆ, Kirkpatrick (Rep. II, p. 50 and subsequently)—Referred to the genus *Nemoræa* Desv. by Osten Sacken (Catalogue, etc., 1878, p. 150). The variety *occropis* of this (Rep. IV, p. 108) is quoted by him as a distinct species under *Exorista*, probably a mistake caused by my employing the wrong figure in the *American Entomologist*, Vol. II, p. 101, where that of *E. flavicauda* is used for *leucanæ*.

LYDELLA DORYPHORÆ Riley (Rep. I, p. 111)—Now included in the genus *Exorista*.

ORTHOPTERA.

* *CECANTHUS NIVEUS*, De Geer (Rep. I, p. 138, and V, p. 120)—This species is common in all parts of the country, and I have proved, by breeding, that its eggs are those described and figured as such in the 5th Report. I agree with Scudder in considering *fasciatus* De Geer but a dark and rather well marked variety of it. Its chirp is intermittent, resembling a shrill *te-reat te-reat te-reat* with a slight pause between each. The eggs and punctures figured on page 119 of the 5th Report (Fig. 47) as probably those of *Orocharis saltator* are, as I have since proved by breeding and by watching the process of oviposition, those of a large species of *Cecanthus*, hitherto, I believe, very generally confounded with *niveus*, and which is described below as *C. latipennis* N. Sp. While *niveus* punctures all kinds of soft stems and pithy twigs, *latipennis* seems to prefer the more slender parts of the Grape-vine. The female, when she has sufficiently proceeded in the act of ovipositing, is so intent that she can very well be watched at night by the aid of a "bull's-eye."

The jaws are first used to slightly tear the outer bark. With the antennæ stretched straight forward and the abdomen bent up so as to bring the ovipositor at right angles with the cane, she then commences drilling, working the abdomen convulsively up and down about twice each second. The eggs, as described in the Report, are laid lengthwise in the pith, but always in two sets, one each side of the hole. The number varies according to the size of the cane, and the distance between the holes is also variable but usually less than in my figure. The hole is usually filled up with a white mucous secretion, though there is very little of it about the eggs. This secretion also doubtless serves to facilitate the drilling. The same female will lay over 200 eggs, and will sometimes puncture the same cane at intervals of $\frac{1}{4}$ inch for $1\frac{1}{4}$ feet or more.

The shrill of *latipennis* is continuous and recalls the trilling of a high-pitched dog-whistle in the distance. The key varies, however, and is sometimes much less high and more musical than at others. The commingled shrill of this species recalls also the distant croaking of frogs in spring. The broad wings are thoroughly elevated during the act or even bent forward, and the vibration is so rapid that there appears

to be no motion. The species, in addition to these differences in stridulation and habits, may be distinguished from *niveus* by the following characters:

ECANTHUS LATIPENNIS N. Sp.—White, the elytra of the ♀ sometimes grayish and the posterior femora in one specimen discolored. Antennæ immaculate, with the basal joints and the front of head usually roseate. Tip of ovipositor black. Pronotum as in *niveus*. Hind wings ♀ as long as the elytra or sometimes a trifle longer; of ♂ somewhat shorter than elytra. Elytra of ♀ irregularly reticulate between the parallel oblique veins, especially toward the base. Elytra of ♂ when unfolded $\frac{1}{2}$ as wide as long, the dorsal surface 14^{mm} to 16.5^{mm} long by 7^{mm} to 8^{mm} wide; the rasp 1.5^{mm} long and the teeth distinctly seen with a lens of low power. Ovipositor 6^{mm} long; subgenital plate broadly excavated. Claspers of ♂ with their tips broad, but slightly broader at base than at tip, not deeply separated.

Described from 15 ♀ specimens from Missouri, 1 ♂ from Alabama, and 1 ♂ from South Texas.

The form of the subgenital plate, the immaculate antennæ with their roseate base, and the larger size serve to distinguish the species as well in the pupa as in the imago state.

E. latipennis is a larger insect than *niveus* usually is. The ovipositor measures 6^{mm} in length, whereas in *niveus* it rarely exceeds 5^{mm} and in only one specimen, a sanguineous variety captured July 10, 1874, does it equal 6^{mm}. The male elytra of *niveus* in only one specimen, captured September 19, 1877, reach 13^{mm} in length by 6^{mm} in width on the upper face, and the size is generally much less. In *niveus* the unfolded male elytra are less than $\frac{1}{2}$, and usually only $\frac{1}{3}$, as wide as long, and the rasp is only 1^{mm} long, and the teeth are not so easily seen. The elytra of *niveus* female sometimes show an irregularity in the reticulation between the parallel oblique veins but never so great an irregularity as in *latipennis*, there being fewer cells. In only one specimen of *latipennis*, a male taken on cotton at Columbus, Tex., are there any black marks on the lower surface of the basal joints of the antennæ, representing the lines or dots which are always present in *niveus*. But the two species are most sharply separated by the form of the subgenital plate of the female, which in *niveus* narrows rapidly towards the tip which has a minute angular notch, and by the form of the male claspers, which in *niveus* have their tips very slender and parallel, being deeply parted, and then retreating rapidly from one another on each side.

Besides *niveus* there are recognized from North America three other species of *Ecantus*, one of which, *californica* Sauss.,* recorded only from California, is described as having the posterior wings abortive.† The other two species, *nigricornis* Walk. from Illinois (description quoted in the *American Entomologist*, Vol. II, p. 207; 1870) and *varicornis* Walk. from Mexico, both described only in the female sex and differing from *niveus* in nothing but the slightly longer hind wings and the slightly greater size of the insect, and in *varicornis* having a slightly longer prothorax, have been retained as distinct species by Saussure. But *niveus*, as may be seen in a series of specimens, varies in these characters indefinitely, just as other species of crickets are admitted to vary; so we may consider Walker's species to be but varieties of *niveus*. They cannot be referred to *latipennis*, for in this species the wings rarely, and then but slightly, exceed the elytra.

One other North American species, *bipunctatus* DeG., has been referred to *Ecantus*. It belongs, however, to the genus *Xabea* and should be known as *Xabea bipunctata* (DeG.).

As the female of *Xabea* has not hitherto been described and Saussure did not recognize the genus as distinct from *Ecantus*, it may be well to give here the characters drawn from both sexes to show how very clearly the two genera differ. The type of the genus is from Sumatra, and Walker, being unacquainted with our species, an Saussure, having only imperfect specimens, both failed to recognize the existence of the genus in North America.

* Études sur les Orthoptères, (in Mission Scientifique au Mexique, etc. Recherches Zoologiques — partie.) 8^{me} livraison; p. 462; 1874.

† By "abortive" is evidently meant, from the description following the diagnosis, simply shorter than abdomen. In this respect and in the male (which alone is described) being shorter than *niveus*, *californica*, which I know only from the description, may most easily be distinguished.

; Walker, Cat. Derm. Salt. Brit. Mus., Pt. I, p. 109.

XABEA Walk.—First joint of antennæ armed with a stout, blunt tooth in front. Female elytra irregularly reticulated, the oblique longitudinal veins not being conspicuous; male elytra with the mediastinal vein strongly arcuated; no humeral angle. Wings twice as long as the elytra. Cerci only half as long as the abdomen, sinuous. Outer valves of the ovipositor ending in a single outwardly directed tooth which is preceded on the outside by a longitudinal series of three teeth; the inner valves compressed, ending in three teeth of which the middle one is much the longest. Posterior tibiae with neither spurs nor serrations and having only 4 apical spurs, 2 within and 2 without; the first joint of posterior tarsi unarmed, the tarsi clearly but 3-jointed, the second joint short as in the other legs; tarsal claws with the inner tooth acute.

OROCHARIS SALTATOR Uhler (Rep. V, p. 119).—The eggs figured and described on page 119 as probably those of this insect are, as above stated, those of *Oecanthus latipennis*. I have, however, frequently obtained the eggs of the *Orocharis* since. In December, 1877, I watched a female ovipositing in the end of a dead and rather soft twig of the Soft-maple at Kirkwood, Mo. The twig had been pruned and the bark was somewhat gnawed by the cricket and the eggs thrust in irregularly from the end and from the sides. Both wood and pith were crammed with eggs, but all longitudinally inserted. The favorite nidus of the species is, however, the soft and somewhat corky, rough bark of the trunk and older branches of the American elm, the eggs being thrust in singly or in small batches, either longitudinally with, or very slightly obliquing from, the axis of trunk or branch. The female is very intent in the act, working her abdomen deliberately from side to side during the perforation. The ovipositor is held more obliquely than in *Oecanthus*.

The egg is amber-colored and very slender and elongate, the tip rather pointed and very faintly opaque with the surface but slightly granulate. It has scarcely any curve and varies from 3.5^{mm} to 4^{mm} in length and from 0.4^{mm} to 0.5^{mm} in diameter at middle.

The stridulation of this cricket is a rather soft and musical piping of not quite half a second's duration, with from 4 to 6 trills, but so rapid that they are lost in the distance. The key is very high, but varies in different individuals and according to moisture and temperature. It most resembles the vibrating touch of the finger on the rim of an ordinary tumbler when three-fourths filled with water—repeated at intervals of from 2 to 4 per second, and it may be very well likened to the piping of a young chick and of some tree frogs. As the species is very common in the Southwest its chirp is everywhere heard and is so distinctive that when once studied it is never lost amid the louder racket of the katydids and other night choristers. It is frequently heard during the day time in cloudy or damp weather, and I have heard it at Saint Louis the first days of November after a slight frost. The elytra in stridulating are raised less than in *Oecanthus* and are depressed at intervals.

The courting of the sexes is amusing. They face each other and play with their antennæ for the best part of an hour or more than an hour. The female is, otherwise, pretty quiet, but the male continually mouths the twig or the bark upon which the courting is being done, and plays his palpi at a great rate, very stealthily approaching nearer to his mate meanwhile. At last the antennal fencing ceases and those of the female bend back and then the male approaches until their heads touch. He then deliberately turns round, elevates the elytra and slips his abdomen under the female, who virtually mounts and assists him, his elytra overshadowing her head.

The eggs of this insect, as also those of *Oecanthus latipennis*, are devoured by a parasitic larva of similar form and size, and which I have not yet reared to the perfect state.

ORCHELIMUM GLABERIMUM, Burm. (Rep. V, p. 123).—The egg-punctures illustrated at Fig. 56 are, as there correctly supposed, those of this species, as I have since proved by watching the act of oviposition and by rearing from the eggs. The insect is very fond of using the tops of corn-stalks for the same purpose.

NEUROPTERA.

CORYDALUS CORNUTUS, L. (Rep. V, p. 141; IX, p. 125)—For additional facts relating to the early larval stages, see my notes on the "Larval Characteristics of Corydalus and Chauliodes and on the development of Corydalus cornutus (Proc. Am. Ass. Adv. Sc., 1878).

MITES.

TROMBIDIUM SERICEUM Say (Rep. VII, p. 175 and subsequently)—For the natural history of this species and the specific identity with it of the larval form known as *Astoma gryllaria* LeBaron, and for further facts respecting the other mites mentioned in the Report, see my remarks in the Transactions of the Academy of Science of Saint Louis, (Vol. III, p. cclxvii, October, 1877) in the *American Naturalist* for March, 1878, and in the First Report of the Commission (p. 306 ff.).

DESCRIPTIONS OF NEW SPECIES AND VARIETIES.

Some systematists have questioned whether descriptions of species in *Agricultural Reports* should be recognized. While my own views on this subject are pretty freely expressed on page 56 of my *Third Missouri Report* and elsewhere, the publication of this *Bulletin* affords a good opportunity to bring the descriptions that are scattered through the nine volumes together, with such notes on synonymy as present knowledge suggests, and such corrections as are given in the *Errata*. In the earlier reports the measurements were expressed in inches and hundredths of an inch, while in the later volumes the metric system was adopted as most convenient and accurate, and the measurements which follow have all been reduced to this standard. All changes of this character or other changes from the original are included in brackets, while the additional notes are in Long Primer type.

HYMENOPTERA.

PORIZON CONOTRACHELI, N. SP.—*Head* pitchy-black, opaque, the ocelli triangularly placed and close together; eyes oval, polished, and black; face covered with a silvery-white pubescence; labrum rufous, with yellowish hairs; mandibles and palpi, pale yellowish-brown; antennæ inserted in depressions between the eyes, reaching to metathorax when turned back, filiform, 24-jointed; black with basal joints 6-1 becoming more and more rufous, the bulbous always distinctly rufous; bulbous rather longer and twice as thick as joint 3; joint 2 about one-third as long. *Thorax* pitchy-black, opaque, the sides slightly pubescent with whitish hairs, the mesothorax rounded and bulging anteriorly, the scutellum slightly excavated and sharply defined by a carina each side; metathorax with the elevated lines well defined and running parallel and close together from scutellum to about one-fourth their length, then suddenly diverging and each forking about the middle. *Abdomen* glabrous, polished, very slender at base, gradually broader and much compressed from the sides at the apex which is truncated; peduncle uniform in diameter and as long as joints 2 and 3 together; joints 2-5 subequal in length; color rufous with the peduncle wholly, dorsum of joint 2, a lateral shade on joint 3, and more or less of the two apical joints superiorly, especially at their anterior edges, black; venter more yellowish: ovipositor about as long as abdomen, porrect when in use, curved upwards when at rest, rufous, with the sheaths longer and black. *Legs*, including trochanters and coxæ uniformly pale yellowish-brown with the tips of tarsi dusky. *Wings*, subhyaline and iridescent, with veins and stigma dark brown, the stigma quite large, and the two discoidal cells subequal and, as usual in this genus, joining end to end, but with the upper veins which separate them from the radial cell, slightly elbowed instead of being straight, thus giving the radial cell a quadrangular rather than a triangular appearance. ♂ differs from ♀ only in his somewhat smaller size and unarmed abdomen. Expanse ♀ 0.32 inch [= 8^{mm}], length of body, exclusive of ovipositor, 0.22 [= 5.5^{mm}]; expanse ♂ 0.28 [= 7^{mm}], length 0.18 [= 4.5^{mm}].

Described from 3 ♀, 1 ♂ bred May 26th-28th, 1870, from cocoons received from Dr.

I. P. Trimble, of New Jersey, and 1 ♀ subsequently received from the same gentleman—all obtained from larvæ of *Conotrachelus nenuphar*.

As I am informed by Mr. E. T. Cresson, of Philadelphia, who pays especial attention to the classification of the *Ichneumonidæ*, it might more properly be referred to Holmgren's genus *Thersilochus*, which differs from *Porizon* in the greater distance between the antennæ at base, and in the venation of the wing.—[Third Rept., p. 28, Fig. 9.

LIMNERIA LOPHYRI, N. Sp.—♀, length 0.30—0.35 inch [7.5—8.7mm]. Head and thorax black with silvery white pile. Antennæ piceous, more than half as long as body; but slightly paler toward tip; bulbous either yellowish or rufous. Ocelli either rufous or black. Mandibles, palpi, front and middle coxæ trochanters and tibiæ, pale yellow. Tegulæ almost white. Abdomen, with faint pile, rufous, the petiole and sides of next joint usually blackish. Hind legs rufous, the base of tibiæ and of tarsi paler.

♂ somewhat smaller, and with more black on the abdomen.

Four ♂'s, 12 ♀'s bred from larvæ of *Lophyrus Abbotii*.—[Ninth Rept., p. 32.

HEMITELES (?) CRESSONII, [N. Sp.]—♂—Length 0.25 [6mm]. Black, opaque, head transversely-subquadrate; face clothed with pale glittering pubescence; spot on mandibles, palpi, scape of antennæ in front and the tegulæ, white; eyes large, ovate; antennæ longer than head and thorax, slender, black; thorax closely and minutely punctured; mesothorax with a deeply impressed line on each side anteriorly; scutellum convex, closely punctured, deeply excavated at base; metathorax coarsely sculptured, truncate and excavated behind, the elevated lines sharply defined, forming an irregularly shaped central area, and a triangular one on each side of it, the outer posterior angle of which is prominent and subacute; wings hyaline, iridescent, nervures blackish, stigma large, areolet incomplete, the outer nervure wanting; legs pale honey-yellow, coxæ paler, tips of posterior femora, and their tibiæ and tarsi entirely blackish; abdomen elongate ovate, flattened, petiolated, the first segment flat, gradually dilated posteriorly, somewhat shining, and indistinctly longitudinally aciculate; the two following segments opaque, indistinctly sculptured; remaining segments smooth and shining.—[First Rept., p. 177. Figured at Pl. II, Fig. 7.

HEMITELES (?) THYRIDOPTERIGIS, N. Sp.—♀ Length 0.36 [inch = 9mm]; expanse 0.50 [inch = 12.5mm]. Ferruginous, opaque. Head transverse, rather broader than thorax, the front much depressed; face prominent centrally beneath antennæ, closely punctured, thinly clothed with pale pubescence; clypeus and cheeks shining; tips of mandibles black; antennæ, long, slender, filiform, ferruginous, blackish at tips; thorax rugose; scutellum prominent, with sharp lateral margins; metathorax prominent, quadrate, abrupt laterally and posteriorly, finely reticulated and pubescent, the upper posterior angles produced on each side into a long, divergent, flattened, subacute spine; disk with two longitudinal carinæ, from which diverges a central transverse carina; tegulæ piceous; wings hyaline, subiridescent; a narrow, dark fuliginous band crosses the anterior pair a little before the middle, and a broad band of same color between middle and apex, this band having a median transverse hyaline streak; areolet wanting, second recurrent nervure straight, slightly oblique; apex of posterior wing fuscous; legs long and slender, ferruginous, more or less varied with fuscous; posterior coxæ, tips of their femora, and their tibiæ and tarsi, fuscous; base of four posterior tibiæ more or less whitish, forming a rather broad annulus on posterior pair; abdomen petiolated, subconvex, densely and finely sculptured, blackish, basal segment tinged with reddish, the second and third segments distinctly margined at tip with whitish; apical segments smooth and shining, thinly pubescent; ovipositor half as long as abdomen, sheaths blackish.

♂.—Not at all like the ♀. Length 0.33 [inch = 8mm], expanse 0.44 [inch = 11mm]. Long, slender, black, polished, without distinct punctures, thinly clothed with white pubescence; palpi white; antennæ long, slender; scape reddish; mesothorax gibbous, with two deeply impressed longitudinal lines; metathorax with well-defined elevated

- lines, forming several irregular areas; sides rugulose, apex without spines or tubercles; tegulae white; wings whitish-hyaline, subiridescent, the nervures and stigma white, subhyaline, venuration as in ♀; legs long, slender, pale honey-yellow; coxae, posterior trochanters, apex of their femora, and their tibiae and tarsi, blackish; base of posterior tibiae with a white annulus; abdomen long, slender, flattened, petiolated, smooth and polished, the apical margin of second segment being narrowly whitish.

Described from four ♀ and one ♂ specimens bred from the same [Thyridopteryx] cocoon.—[First Rept. p. 150. Figured at Pl. II, Figs. 11, 12.

The species is quite common in Washington, D. C., and is often attacked by a secondary Chalcid parasite.

MICROGASTER LIMENITIDIS, N. Sp.—♂ ♀. Length 0.09 inch [= 2 $\frac{1}{2}$ mm]. Color pitchy-black. Antennae black, about as long as body; palpi whitish. *Thorax* minutely punctured. *Abdomen* with the two or three basal joints emarginate and rugose, the terminal joints smooth and polished. *Legs* dusky; front and middle femora yellowish, hind femora black; front and middle tibiae yellowish, hind tibiae with terminal half dusky, but the spur pale; front and middle tarsi yellowish tipped with dusky, hind tarsi dusky above, paler below. *Wings* hyaline, iridescent, the nervures and stigma black or dark-brown, the radial nervule, the cubital nervules and the exterior nervule of the discoidal cell, sub-obsolete.

Described from 6 ♀, 1 ♂, bred from larvae of *Limentis dissipus*.—[Third Rept., pp. 156, 159.

The specimens referred to in connection with this description as bred from *Gelechia gall-solidaginis* prove to belong to a distinct species. Both species belong to the genus *Apanteles* Först. as at present accepted. See my "Notes on N. A. Microgasters" (Trans. Ac. Sc. St. Louis, IV, *Author's separata*, p. 13.)

MICROGASTER GELECHIE.—Length 0.20 [= 5 mm] ♂ ♀.—Black, clothed with a short, thin, glittering, whitish pubescence, most dense on the face, which latter is closely punctured; occiput and cheeks shining; mandibles rufopiceous; palpi whitish; eyes pubescent; antennae as long as the body in ♂, shorter in ♀, 18-jointed; thorax shining, feebly punctured, mesothorax closely and more strongly punctured, with a deeply impressed longitudinal line on each side over base of wings; scutellum smooth and polished, the lateral groove broad, deep, arched and crenulated; metathorax opaque, densely rugose, with a sharp, central, longitudinal carina, and a smooth, flat, transverse carina at base; tegulae testaceous, wings hyaline, iridescent, apex smoky, nervures blackish, areolet complete, subtriangular, radial nervure indistinct; legs pale honey-yellow, coxae blackish, pale at tips, middle pair in ♀ concolorous with legs; abdomen with the two basal segments densely rugose and opaque, the remainder smooth and shining; venter more or less varied with pale testaceous.—[First Rept., p. 178.

This is a true *Microgaster*.

PERILITUS INDAGATOR, N. Sp.—Imago—♀, *Head* almost glabrous, transverse, deep honey-yellow, the trophi pale, except the tips of jaws, which are dusky; ocelli touching each other, black; eyes black, very large, occupying nearly the whole side of face, and with a few very short hairs; antennae with about 24 joints, pale fuscous; reaching, when turned back, to about the middle of abdomen. *Thorax* honey-yellow beneath and very slightly pubescent; very finely punctured and slightly pubescent above; prothorax honey-yellow and prominently convex; mesothorax with lateral and posterior sutures black; metathorax black. *Abdomen* with the pedicel black and slightly punctured; depressed, narrow at base, widening behind, slightly pubescent above; the other joints glabrous, polished, deep honey-yellow, the second joint largest and as long as all the subsequent ones together; ovipositor extending about the length of the abdomen beyond its tip, rufous with the sheaths black. *Legs*

pale honey-yellow, the tarsi, especially at tips, slightly dusky, the hind femora and tibiae a little dusky towards tips, and a narrow rufous ring at base of former. *Wings* hyaline, iridescent; veins brown; stigma honey-yellow, with an opaque brown cloud; two cubital cells, the outer small, sub-quadrate; the radial large; one discoidal, long and narrow. Length, exclusive of ovipositor, 0.18 inch [= 4.5^{mm}].

Described from 1 ♀ bred from *Acrobasis juglandis*, LeB.—[Fourth Rept., p. 43.

SPATHIUS TRIFASCIATUS, N. Sp.—♀. Average length, 0.18 inch [= 4.5^{mm}]. Color, light-brown. *Head* pubescent, palpi long and pale; eyes black; ocelli black, contiguous; antennae smooth, pale, and reaching to second abdominal joint. *Thorax* with sutures dark-brown; legs more or less dusky, the tarsi (except at tip) an annulus at base of tibiae, and the trochanters, pale; wings fuliginous, with a white fascia at base, at tip and across outer middle of front wing, including the inner half of stigma, the outer half of which is dark-brown; middle fascia most clearly defined. *Abdomen* slightly pubescent at sides and tip; first joint pale, petiolate, and with short and longitudinal aciculations above; second joint pale above, the others more or less brown; ovipositor pale, dusky at tip, and long as abdomen.

One bred specimen.

♂—Differs in being much darker colored, the head, thorax and femora being brown, and the metathorax and base of first abdominal joint black.

One bred specimen.—[Fifth Rept., p. 106.

BRACON CHARUS, N. sp.—♀ Length of body 0.35 inch [= 8.7^{mm}]; of ovipositor 0.40 inch [= 10^{mm}]; expanse of wing 0.65 inch [= 16^{mm}]. Colors black and deep rufous. Head, thorax, legs and antennae polished black, the legs and sides of head and thorax with a fine grayish pubescence; trophi also black. Abdomen uniformly deep rufous. Terebra of ovipositor pale yellow, the sheaths black and very faintly pubescent. Wings deep fuliginous with a faint zig-zag, clear line across the middle from the stigma.

Described from 7 ♀'s, all bred from *Chrysobothris femorata*.—[Seventh Rept., p. 75. Fig. 13.

BRACON SCOLYTIVORUS, Cress.—♀—Black, shining, metathorax and base of abdomen pubescent; face, anterior orbits, lower half of cheeks, clypeus, mandibles, except tips, palpi, tegulae, legs, including coxae, and abdomen, honey-yellow, the latter darker; posterior coxae sometimes dusky; antennae at base beneath, dull testaceous; wings fuliginous, apical half paler, iridescent; abdomen shining, first segment whitish laterally, the base and disc sometimes dusky; base of second segment with a large subtriangular flattened space inclosed by a deep groove, the posterior side of which is generally blackish; ovipositor longer than abdomen; sheaths black; length, .15—.17 inch [= 3½—4½^{mm}].

♂—More pubescent; posterior coxae blackish, also the femora above, especially the posterior pair; posterior tibiae dusky; abdomen black, polished; apex of first, basal half of second, and sides of apical segments more or less honey-yellow; sides of basal segment whitish; wings paler; abdomen narrower and rather more convex; length, .16 inch [= 4^{mm}].

Three ♂, three ♀ specimens.—[Mr. E. T. Cresson, in Fifth Rept., p. 106.

SIGALPHUS CURCULIONIS, Fitch.—*Imago*.—*Head* black, sub-polished, and sparsely covered on the face with short whitish hairs; ocelli touching each other; labrum and jaws brown; palpi pale yellow; antennae (Fig. 7, c) 27-jointed, filiform, reaching, when turned back, to middle joint of abdomen and beyond, the bulbous and small second joint rufous and glabrous, the rest black or dark brown, though 3-10 in many specimens are more or less tinged with rufous; 3-14 very gradually diminishing in size; 14-27 sub-equal. *Thorax* black, polished, the metathorax distinctly and broadly punctate, and the rest more or less distinctly punctate or rugose, with the sides sparsely pubescent. *Abdomen* pitchy-black, flattened, the dorsum convex, the venter concave, and the sides narrow-edged and slightly carinated; the three joints distinctly separated and of about equal length; the first joint having two dorsal longitudinal carinae down the

middle; all densely marked with very fine longitudinally impressed lines, and sparsely pubescent; (Dr. Fitch in his description published in the *Country Gentleman*, under date of September, 1859, states that these lines leave "a smooth stripe along the middle of its second segment and a large smooth space on the base of the third;" which is true of a few specimens, but not of the majority, in which the impressed lines generally cover the whole abdomen.) Ovipositor longer than abdomen, but when stretched in a line with it, projecting backwards about the same length beyond; rufous, with the sheaths black. Legs pale rufous, with the upper part of hind tibiæ and tarsi, and sometimes the hind femora, dusky. Wings subhyaline and iridescent, the veins pale rufous, and the stigma black. Length ♀, 0.15–0.16 inch [=3.7–4^{mm}], expanse 0.30 [=7.5 mm]; ♂ differs only in his somewhat smaller size and in lacking the ovipositor. In many specimens the mesothorax and the eyes are more or less distinctly rufous.

Described from 50 ♀♀, 10 ♂♂, bred June 23d–July 29th, 1870, from larvæ of *Conotrachelus nenuphar*, and 2 ♀♀ obtained from Dr. Fitch.

Larva (Fig. 8, a)—White, with translucent yellowish mottlings.

Pupa (Fig. 8, c ♀)—0.17 inch [=4^{mm}] long; whitish, the members all distinct, the antennæ touching hind tarsi, the ovipositor curved round behind, reaching and touching with its tip the third abdominal joint, which afterwards forms the apical joint of imago; five ventral joints, which in the imago become much absorbed and hidden, being strongly developed.

Cocoon (Fig. c, b)—Composed of one layer of closely woven yellowish silk.

VARIETY RUFUS—Head, thorax, and most of the first abdominal joint entirely rufous, with the middle and hind tibiæ dusky, and the ovipositor three times as long as abdomen and projecting more than twice the length of the same beyond its tip.

Described from three ♀♀ bred promiscuously with the others. This variety is slightly larger and differs so remarkably from the normal form that, were it not for the absolute correspondence in all the sculpturing of the thorax and body, and in the venation of the wings, it might be considered distinct. The greater length of the ovipositor is very characteristic, and accompanies the other variation in all three of the specimens.—[Third Rept., p. 27. Fig. 7.

EURYTOMA BOLTERI, N. Sp.—♀ Length 0.18 inch [=4.5 mm]. Antennæ black, not much longer than the face, perceptibly thicker towards the end, and apparently 10-jointed, though the three terminal joints are almost always confluent. Dimensions and appearance of joints, represented in the annexed Figure 97, a. Head and thorax rough-punctured and finely bearded with short, stiff gray hairs. Abdomen about as long as thorax, scarcely so broad, viewed from above, but wider viewed laterally; highly polished, smooth and black, the three terminal segments with minute stiff gray hairs along the sutures; visibly divided into seven segments, the four anterior ones of about equal length, the two following shorter, and the terminal one produced into a point. Legs fulvous with the coxæ, [trochanters], thighs and more or less of the shanks blackish-brown. Wings perfectly transparent, glossy, colorless, and with the nerves very faint.

♂ Measures but 0.14 inch [=3.5 mm], and differs in the antennæ, being twice as long as the face, in their narrowing towards the tip and in being furnished with whorls of long hairs. The number of joints are not readily made out, and I have consequently presented at Figure 97, b, a magnified figure. His body is but half as wide and half as long as the thorax viewed from above, and not quite as broad as the thorax, viewed laterally; it also lacks the produced point of the ♀. His wings are also cut off more squarely and more distinctly nerved.—[First Rept., p. 187. Pl. II, Fig. 9.

For further descriptive details see Walsh's posthumous paper on the *Eurytomides* (*Am. Ent.* II, p. 293–9), where the insect is looked upon as a variety of *Eurytoma diastrophæ*.

[**TRICHOGRAMMA MINUTA**, N. Sp.] * * * It comes nearest the genus *Trichogramma*, Westw., and may be provisionally called *Trichogramma* (?) *minuta*. It differs

from that genus and from all other Chalcididan genera with which I am acquainted, in the antennæ being but 5-jointed (scape, plus 4 joints), the scape stout and as long, or longer, than joints 2, 3, and 4 together; joints 3 and 4 small and together as long as joint 2; 5 very stout, fusiform, and as long as 2, 3, and 4 together. The legs have the trochanters stout and long, the tibiæ not quite so long nor so stout as the femora, and with a long tooth; the tarsi are 3-jointed, with the joints of equal length and with the claws and pulvilli sub-obsolete. The abdomen is apparently 6-jointed, the basal joint wide, the 2nd narrower, 2-5 increasing in width till 5 is as wide as 1. The ovipositor of ♀ extends a little beyond the apex, and starts from the anterior edge of the 5th joint.—[Third Rept., p. 158. Fig. 72.

The species was provisionally referred to *Trichogramma*, and I subsequently proposed for it the generic name *Pentarthron* (Record of Am. Ent. 1871, p. 8). *Pentarthrum* has, however, been used by Wollaston in beetles, and until allied genera are better characterized than at present, the old generic name may be retained.

COLEOPTERA.

BRUCHUS FABÆ N. Sp. (Fig. 19.)—General color tawny-gray with more or less dull yellowish. *Body* black tinged with brown and with dull yellowish pubescence, the pygidium and sides of abdomen almost always brownish. *Head* dull yellowish-gray with the jaws dark brown and palpi black; antennæ not deeply serrate in ♀, more so in ♂; dark brown or black with usually 5, sometimes only 4, sometimes 4 and part of 5 basal joints, and with the terminal joint, more or less distinctly rufous, or testaceous, the color being so slight in some specimens as scarcely to contrast at all with the darker joints. *Thorax* narrowed before, immaculate, but with the pubescence almost always exhibiting a single pale medio-dorsal line, sometimes three dorsal lines, more rarely a transverse line in addition, and still more rarely (two specimens) forming a large dark, almost black patch each side, leaving a median stripe and the extreme borders pale and thus approaching closely to *erythrocerus* Dej.; base with the edges almost angulated; central lobe almost truncate and with a short longitudinal deeply impressed median line; no lateral notch; scutel concolorous and quadrate with the hind legs more or less notched. *Elytra* with the interstitial lines having a slight appearance of alternating transversely with dull yellowish and dusky; so slight however that in most of the specimens it can hardly be traced: the dark shadings form a spot on each shoulder and three transverse bands tolerably distinct in some, almost obsolete in others, the intermediate row being the most persistent and conspicuous: between these dark transverse rows the interstices are alternately more or less pale, especially on the middle of the 3rd interstitial lines. *Legs* covered with grayish pubescence, and with the tibiæ and tarsi, especially of first and second pair, reddish-brown; the hind thighs usually somewhat darker, becoming black below and inside, and with a tolerably long black spine followed by two very minute ones. Length 0.09–0.14 inch [= $\frac{1}{4}$ – $\frac{3}{5}$ mm]. Described from 40 specimens all bred from different kinds of beans. Hundreds of others examined.

This insect has been for several years ticketed in some of the Eastern collections by the name of *B. fabæ*, or else, what is worse, the corruption of it, *fabi*. The former name has been disseminated by my friend F. G. Sanborn of Boston, Massachusetts, who says that he received the weevil thus named, together with beans attacked by it, in the year 1862 from Rhode Island. The name was credited to Fabricius, but I can find no notice in any of the works I possess of any European *Bruchus fabæ*, and several of my Eastern correspondents who have access to large libraries have been unable to find any description or allusion to a species by that name. Dr. LeConte has given it the MS name of *varicornis* but as his description will not appear perhaps for years to come and as no comprehensive description has yet been published, I have deemed it advis-

able to dispel in a measure the confusion that surrounds the nomenclature of the species. There is need of a description of so injurious an insect, and as *fabæ* is not pre-occupied I adopt the name because it is entirely appropriate and because it is more easily rendered into terse popular language than *varicornis*.

It resembles most closely of any other species which I have seen, the *B. erythrocerus*, Dej., which, however, is smaller, and differs in having a narrower thorax which has light sides and a dark, broad dorsal stripe divided down the middle by a pale narrow line: *erythrocerus* is further distinguished by the antennæ being entirely testaceous and the hind thighs more swollen.

From *obsoletus* Say, *fabæ* differs materially: *obsoletus* is a smaller species, dark gray, with the antennæ all dark, the pygidium not rufous, the thorax with a perceptibly darker dorsal shade so that the sides appear more cinereous, a white scutel, and each interstitial line of the elytra with a slight appearance of alternating whitish and dusky along its whole length; for though there is nothing in Say's language to indicate whether it is the interstitial lines that alternate transversely, whitish and dusky, or each line that so alternates longitudinally, I find from an examination of a specimen in the Walsh collection, that the latter is the case, and so much so that the insect almost appears speckled. The two species differ both in size and color, though, as Say's description is short and imperfect it is not surprising that *fabæ* should have been referred to it.

From the European bean-feeding *Br. flavimanus* (which is apparently either a clerical error for, or a synonym of *Br. rufimanus*, Schœnh.) as described by Curtis, it differs notably; as it does likewise from their *Br. serratus*, Ill., which also attacks beans.

Dr. LeConte, according to Mr. Rathvon, was inclined to consider this insect the *obsoletus* of Say, from the fact that in specimens which the latter gentleman sent him, the antennæ were not varied as in his MS. *varicornis*, but uniformly black. A few specimens which Mr. Rathvon sent me nearly two years ago, taken from the same lot as were those which he forwarded to Dr. LeConte, were singularly enough, all decapitated but two; and these two showed the varied antennæ. These specimens had all been kept in alcohol, and I am greatly inclined to believe that the uniformly dark appearance of the antennæ that was noticed by LeConte was the effect of the alcohol on those which naturally had the rufous joints but faintly indicated. At all events, though Mr. Rathvon tells me that he found a small proportion of beetles with dark antennæ, after examining, at my suggestion, over two hundred specimens that had thus been kept in alcohol; yet from over one hundred specimens which he had the kindness to send me, I only find (after thoroughly drying them) three with the terminal joint really as dark as the subterminal, and not a single one in which the rufous basal joints cannot be more or less distinctly traced.—[Third Rept., p. 55-56. Fig. 19.

Since the above was written, Dr. Horn has given us a revision of the *Bruchidæ* of the United States (Trans. Am. Ent. Soc., Vol. IV, 1873), in which he makes *fabæ* a synonym of *obsoletus* Say, expresses regret that another synonym must be added and states that the *obsoletus* which I referred to is the *transversus* Say (= *hibisci* Oliv.). This criticism is not deserved, and while the decision of one who has done such excellent work in Coleoptera as Dr. Horn has will be generally accepted as final, yet no one can compare his redescription of *obsoletus* with Say's description and not feel that the two apply to different insects. *Fabæ* is usually one-third larger, tawny-gray above with vari-colored antennæ, concolorous scutel, emarginate behind, and rufous legs and abdomen; *obsoletus*, on the contrary, according to Say, is blackish-cinereous, the thorax cinereous each side, with a whitish scutel and with the abdomen and legs not differing in color from the rest of the body. *Fabæ* breeds in beans; *obsoletus* in the seeds

of *Astragalus*. Indeed one would be far more justified in considering *B. alboscuteUellatus* Horn a synonym of *obsoletus* Say than in considering *fabæ* a synonym of it, and when the *Bruchus* from *Astragalus* in the Eastern States is bred, I fully expect Dr. Horn to change his mind. Nor is the assumption justifiable that the *obsoletus* referred to by me, and destroyed in the Walsh collection, is *hibisci* Oliv. It was far more like *alboscuteUellatus* as far as I remember, and there is not a character about this species which does not accord with Say's description of *obsoletus* except that the scutel is described as rounded, while that of *obsoletus* is described by Say as quadrate. I am of opinion that too much stress has been laid on this difference by Dr. Horn, as, when the pubescence is separated behind, the scutel appears quadrate, whereas in *fabæ* it appears bifid. The scutel of *alboscuteUellatus* when denuded is quadrate, but it is doubtless the clothed appearance which Say described. Say, as appears from his text, had abundant material, and it is assuming too much to suppose that he could overlook the striking differences in size and coloration of *fabæ*, as above indicated.

The specific name *fabæ* was used by Brullé for *Bruchus pisorum* Linn.

MADARUS VITIS, N. Sp.—Length, exclusive of rostrum 0.10 [inch=2.5mm]. Color uniformly rufous, without maculations, the eyes alone being darker. Highly polished; rostrum arcuated, stout and about as long as thorax; thorax and body with extremely minute and distant punctures, anterior margin of thorax abruptly narrowed, especially laterally, into a collar; elytra slightly undulate, with 4 distinct elevations, one on the extreme outer margin close to the thorax, and one on the middle of each, near the extremity.—[First Rept., p. 132. Fig. 74.]

For further details as to the synonymy of this insect, see *American Entomologist* I, p. 105. Dr. LeConte's description of *Baridius sesostris* was published about three months earlier than my own and he subsequently (Proc. Amer. Phil. Soc., Vol. XV, 1876, p. 299) erected the genus *Ampelogypter* for this and two other species, so that *Madarus vitis*=*Ampelogypter sesostris* Lec.

ANALCIS FRAGARIÆ, N. Sp.—*Imago*, (Fig. 14, b, c)—Color deep chestnut-brown, sub-polished, the elytra somewhat lighter. Head and rostrum dark, finely and densely punctate and with short fulvous hairs, longest at tip of rostrum; antennæ rather lighter towards base, 10-jointed, the scape much thickened at apex, join 2 longest and robust, 3 moderately long, 4-7 short, 8-10 connate and forming a stout club. Thorax dark, cylindrical, slightly swollen across the middle and uniformly covered with large thimble-like punctures, and with a few short coarse fulvous hairs, unusually arranged in three more or less distinct longitudinal lines; pectoral groove ending between front legs. Abdomen with small remote punctures and hairs which are denser towards apex. Legs of equal stoutness, and with shallow dilated punctures and uniform very short hairs. Elytra more yellowish-brown, dilated at the lower sides anteriorly, and with about 9 deeply-punctured striae, the striae themselves sometimes obsolete; more or less covered with coarse and short pale yellow hairs which form by their greater density, three more or less conspicuous transverse bands, the first of which is at base; between the second and third band, in the middle of the elytron, is a smooth dark-brown or black spot, with a less distinct spot of the same color below the third, and a still less distinct one above the second band. Length 0.16 inch [=4mm].

Described from four specimens bred from strawberry-boring larvae. The black spots

on the elytra are quite distinct and conspicuous on two specimens, less so on one, and entirely obsolete on the other.

Larva, (Fig. 14 a)—White with back arched Lamellicorn-fashion. Head gamboges yellow, glabrous, with some faint transverse striations above mouth; mandibles rufous-tipped with black; labrum emarginate, and with palpi, pale. A faint narrow dorsal vascular line. Legs replaced by fleshy tubercles. Length 0.20 inch [=5mm] when stretched out.—[Third Rept., p. 44. Fig. 14.

Say's generic name *Tyloderma* having priority over Schönherr's *Analcis*, the name of this insect becomes *Tyloderma fragariæ*.

LEPIDOPTERA.

ÆGERIA RUBI, N. Sp.—*Imago*.—Expanse, ♂, 1.00 [inch=25mm]; ♀, 1.25 inch [=31mm]. Front wings transparent, with a broad costal border extending half the width of wing at base, a narrow discal spot, and more or less of the tip dull-ferruginous; the inner border, the inner longitudinal vein, the intermediate space toward posterior angle, and sometimes its whole length, of the same color; veins brownish within and black without the discal spot. Hind wings perfectly transparent, or rarely with a few sparse ferruginous scales; the transverse discal vein pale, the others pale at base, but black toward extremities; costa narrowly golden-yellow, becoming darker toward apex. Fringes dark-brown, those of hind wings appearing darkest by virtue of a dark wing border. Under surface somewhat paler. Abdomen stout, with a very slight anal tuft in ♀; a stouter one in ♂. Antennæ blue-black, not enlarging toward tip, quite pectinate in ♂. Palpi, a narrow ring around neck, the sides of the collar, a broad band curving across tegulæ and around the base of wings, a faint line across middle of thorax, two faint longitudinal lines between it and collar, legs, except outer base (sometimes whole length) of femora and tibiæ, hind third of abdominal joints, and a dorsal and lateral series of abdominal tufts or patches (the dorsal ones, especially on 3d and 7th joints, most persistent and conspicuous)—all golden-yellow: the rest of body black. The orbits are of a somewhat paler-yellow, and the face either gray or bluish.

♂ differs from ♀ in the darker color of primaries, the narrower fringe of secondaries, the narrower ferruginous spot at apex of primaries, the more tufted abdomen, the broader and darker anal tuft, and the pectinate antennæ.

Described from 6 ♂'s, 6 ♀'s, bred from *Rubus*. Approaches nearest to *Trochilium marginatum* Harr., and *T. tibiale* Harr., from which it differs in the thoracic marks and the abdominal tufts.

Larva—Length 0.90–1.10 inch [=22.5–27.5 mm]; diameter 0.18 [=4.5mm]. Color pale-yellow. Head dark-brown, with a few whitish hairs; mandibles black, the other trophi paler. Cervical shield horny, pale-brown. Each joint with 8 pale, shiny piliferous spots, transversely arranged on 2, 3 and 12; the dorsal 4 quadrangularly arranged and the lateral 2 interrupted by stigmata on all the others. Thoracic legs slightly tinged with brown; prolegs, with the hooklets dark. Several specimens examined.—[Sixth Rept., p. 113. Fig. 30.

ACHRONYCTA POPULI, N. Sp.—*Larva*—Length 1.50 [inch, =37mm]. Color yellowish-green, covered with long soft bright yellow hairs which spring immediately from the body, part on the back, and curl round on each side. On top of joints 4, 6, 7, 8 and 11, a long straight double tuft of black hairs, those on 7 and 8 the smallest. Head polished black with a few white bristles. Joint 1 with a black spot above, divided longitudinally by a pale yellow line, giving it the appearance of a pair of triangles. Joint 2 with two distinct black spots. Thoracic legs black; prolegs black with brownish extremities. Venter greenish-brown. Described from many specimens. When young of a much lighter color, or almost white, with the black tufts short but

more conspicuous, with a distinct black dorsal line, two lateral purplish-brown bands, and with hairs white, sparse and straight.

Individuals vary much: some have a black dorsal line, some have but three distinct black tufts; some have a sixth tuft of black hairs on joint 9, and others have a few black hairs on all but the thoracic joints. Just before spinning up, many of the hairs are frequently lost, and the body acquires a dull livid hue.

Moth.—♀, front wings, white, finely powdered with dark atoms which give them a very pale gray appearance; marked with black spots as follows: a complete series of small spots on posterior border extending on the fringes, one between each nerve; near the anal angle between nerves 1 and 2 a large and conspicuous spot bearing a partial resemblance to a Greek *psi*, placed sidewise, and from this spot a somewhat zigzag line running parallel with posterior border, but somewhat more arcuated towards costa, least distinct between nerves 3 and 4, and forming a large distinct dart-like spot between nerves 5 and 6; space between this line and posterior border, slightly darker than the rest of the wing-surface on account of the dark atoms being more thickly sprinkled over it; four costal marks, one subobsolete in a transverse line with the reniform spot, one conspicuous about the middle, and in a line with reniform spot and anal angle, one about the same size as the last and looking like a blurred X about one-third the length of wing from base, and one subobsolete, near the base; orbicular spot flattened and well defined by a black annulation; reniform spot indicated by a blurred black mark running on the cross-vein and sometimes somewhat crescent-formed; a V-shaped spot pointing towards base half-way between costa and interior margin, in a transverse line with the large costal spot which looks like a blurred X; a blurred mark in middle at base, and lastly a narrow spot on the inferior margin, half-way between base and anal angle. Hind wings same color as front wings; somewhat more glossy, with the lunule, a band on posterior border one-fourth the width of wing, and sometimes a narrow coincident inner line, somewhat darker than the rest; the posterior border also with a series of spots one between each nerve. Under surface of front wings pearly-white with an arcuated brown band, most distinct towards costa, across the posterior one-third, all inside of this band of a faint yellowish-brown; lunule and fringe spots distinct, and with a faint trace of the *psi*-spot; hind wings uniform pearly-white with a distinct and well defined dark wavy line running parallel with posterior margin across the posterior one-third of wing, and with the lunule and fringe spots distinct. Antennæ simple and bristle-formed, gray above, brown beneath. Head thorax and body, both above and below, silvery-gray. Legs with the tarsi alternately dusky and gray. ♂ differs from ♀ by his somewhat stouter antennæ; much narrower body, and narrower wings and fringes, the front wings having the apex more acuminate, and the hind wings scarcely showing the darker hind border.

Described from 2 ♀, 2 ♂ all bred. In the ornamentation of the front wings this species bears some resemblance to the European species *tridens* and *psi*, but otherwise differs remarkably, and especially in its larval characters. It bears a still closer resemblance both in the larva and imago state to the pale variety of a common species known in England as the "Miller" (*A. leporina*), but judging from the figures and description in "Newman's Natural History of British Moths," it may be easily distinguished from *leporina* by the well defined orbicular spot, by the greater proximity of the two large costal spots, by lacking a round spot behind the disk, and by the more prolonged apex. It differs also in the larva state from *leporina* which feeds on the Birch. It likewise closely resembles *interrupta*, though the larvæ are remarkably different; and it also resembles *lepusculina*, the larva of which is unknown; but the specific differences will be readily perceived upon comparing Guenée's descriptions. How near it approaches to *Acronycta occidentalis*, Grote, it is impossible to tell, as the author's description is exceedingly brief, considering the number of closely allied forms; but as that species has a bright testaceous tinge on the reniform spot, it evidently differs from mine. Harris's *Apatela* [*Acronycta*] *Americana*, though very differ-

ent in the imago, yet closely resembles *populi* in the larva state. I have on two occasions found the larva of *Americana* feeding on the Soft Maple, and it may be distinguished from *populi*, by its greater size; by the paler color of the body; by the hairs being paler, more numerous, shorter and pointing in all directions, especially anteriorly and posteriorly of each segment; by having on each of joints 4 and 6 two distinct long black pencils, one originating each side of dorsum, and on joints 11 one thicker one originating from the top of dorsum; by a substigmatal row of small black spots (three to each segment, the middle one lower than the others) and by a trapezoidal velvety black patch starting from anterior portion of joint 11 and widening to anus.—[Second Rept., pp. 120, 121. Figs. 87, 88.

Grote refers it, in his *List*, to *lepusculina* Gn.; having, I believe, seen the type. Guenée must have had a uniformly colored and pale specimen as my typical specimens have a distinct orbicular mark, deeper subterminal markings and the terminal space contrasting by its darker gray with the rest of primaries—all unmentioned in Guenée's description.

XYLINA CINEREA, N. Sp.—*Larva*—Length when full grown 1.20—1.30 inches [=30—32^{mm}], color shiny silvery-green on the back, darker below. A medio-dorsal cream-colored stripe; a subdorsal one represented by 3 or 4 irregularly shaped spots on each joint. A broad deep cream-colored stigmatal line, with a few green dents in it, extending to anal prolegs. Four slightly elevated cream-colored spots, encircled by a ring of rather darker green than the body, in the dorsal space, and in the subdorsal space there are four or more similar but smaller spots. Venter glaucous-gray. Head as large as joint 1, free, glassy-green with white mottlings at sides and top, and pearly-white lips. Thoracic legs whitish. Prolegs concolorous with venter. When young the body is darker and the markings paler. Described from two living specimens.

Imago (Fig. 57, b)—*Front wings*, with the ground-color pale cinereous shaded and marked either with light brown, having a faint purplish tint, or with darker brown, having a similar reflection, or with a colder grayish-brown with the faintest moss-green reflection: in the first two cases the dark color either blends and suffuses with the ground-color so as to give the wing a nearly uniform and smooth appearance, or else contrasts sufficiently to bring out all the marks distinct; in the latter case (two specimens) the markings are very distinct and the ground color is whiter and more irrorate. In the well-marked specimens the usual lines are readily distinguished, the basal half line, transverse anterior and transverse posterior being quite wavy, pale, and bordered each side with a dark shade, the median shade dark and well defined and the subterminal line, though sometimes pale near costa, forming a series of dark angular spots: in the more uniform specimens these lines are barely distinguishable and perhaps the most constant is the sub-terminal which most often takes the form of a series of dark angular spots: the ordinary spots have a pale inner and a more or less distinct dark outer annulation; the orbicular is larger than the reniform and is sufficiently double to take on the form of an 8, the upper part of which is always largest and with the interior space paler than the general surface, while that of the lower part is either concolorous or darker; the form is, however, quite irregular and differs sometimes in the two wings of the same species: the reniform spot is generally well defined, and is either darker, or has a tinge of reddish-brown, interiorly: at the base of the wing is a more or less distinct pale space occupying the upper half, and bordered below by a brown line which is straight about half its length and then extends upwards and outwards towards transverse anterior. A tolerably distinct terminal line, with the fringes dark. In taking a general view of the varying specimens this pale basal space, the pale upper part of the orbicular and the dark subterminal line, seem to be the most constant characters of the species. *Hind wings* gray-brown in-

clining to cinnamon-brown, with the posterior border but slightly darker and the fringe paler. Under surface quite uniform, that of front wings being nacreous gray with a faint discal spot and with a narrow costal and broad terminal border of pale fulvous, dusted with purple-gray; the hind wings of this last color with the lunule and line distinct. *Head* nearly entire, though the quadrid arrangement of the hairs is traceable; palpi hairy throughout. *Thorax* quite square, of same color as primaries and with the collar bordered behind with brown and sometimes the edges of the tegulæ similarly bordered. *Abdomen* of same color as hind wings with lateral tufts, and cut off squarely at apex. Expanse 1.32—1.52 inches [= 34—45^{mm}].

Described from 3 specimens fed on grape-vine, 2 on peaches and 1 on *Cercis canadensis*. Other captured specimens examined.

This species is the analogue of, and very closely resembles the European *Xylina conformis*, which is known under various synonyms. A specimen sent to Mr. P. C. Zeller of Stettin; Prussia, was, however, pronounced distinct. The well-marked irrorate form still more closely resembles Guenée's *cinerosa* found in Switzerland, and which he himself thinks may prove to be a variety of *conformis*. The more I study the species of the NOCTUIDÆ as they occur in nature, the more I am struck with their great variability, and there can be no doubt that many of the so-called species will turn out to be but varieties when we better understand them. In this large family none but the more strikingly marked species should ever be described without an accompanying description of their preparatory states and of their principal variations. I am unacquainted with any of Walker's species except *subcostalis*, which is very different, and if this should prove to be a synonym of any of them the fault must be laid to the difficulty under which the naturalist in the Western States labors for want of proper libraries to refer to. It differs essentially from Grote's *Bethunei* and *capax* as described and illustrated in Volume I of the Transactions of the American Entomological Society. I am informed by Mr. [J.] A. Lintner of Albany, N. Y., that Dr. A. Speyer of Rhoden, Fürstenthum Waldeck, Prussia, who gives much attention to the Noctuidæ, has it marked *Celana oblonga* in his MS., but the insect evidently does not belong to that genus, and as the German pronunciation of *Xylina* much resembles the English pronunciation of *Celana*, the reference to the latter is doubtless due to a verbal misunderstanding.—[Third Rept., pp. 135, 136. Fig. 57.

Now referred, in Grote's *List of Noctuidæ of N. A.*, to Hübner's genus *Lithophane*.

AMPHIPYRA CONSPERSA, N. Sp.—*Larva*.—Found full grown July 2, 1867, on Hazel. No pyramidal hump, and of a uniform emerald-green, the dorsal palpitations visible and the stigmata pale, with a black annulation, but with no other markings either on the head, body, or legs.

Imago.—Like *pyramidoides* in every particular except that the brown of front wings is almost uniformly spattered over, more or less suffusely, with pale-grayish spots, so that no regular marks appear. The costal marks are, however, tolerably distinct as in *pyramidoides*, and by careful examination and comparison traces of the more conspicuous marks of that species may be discerned.

Described from one ♀ bred July 31.—[Third Rept., p. 75.

As remarked at the time, the specimen from which the description was made was a bred one and perfect. Grote, in his *List of Noctuidæ*, considers it simply an aberration of *pyramidoides*, but this can hardly be the case, as the larva also shows differences.

AGROTIS SCANDENS, N. Sp.—*Larva*.—Average length when full grown 1.40 [inch, = 35^{mm}]. Ground-color very light yellowish gray, variegated with glaucous in the shape of different sized patches, which are distinctly seen under the lens to be separated by fine lines of the light ground-color. A well-defined dorsal and less distinct

subdorsal and stigmatal line, caused by these patches becoming larger and darker; another and still less distinct line of the same kind under stigmata. The dorsal line frequently with a very fine white line along its middle, especially at sutures of segments. Piliferous spots in the normal position; those above black, those at the sides lighter. Stigmata black. Head and cervical shield tawny, the latter with a small black spot each side, the former with two in front, and two eye-spots each side. Caudal plate tawny, speckled with black. Venter and legs glaucous. Bristles fine and small. Filled with food it wears a much greener appearance than otherwise, while when young it is of a more uniform dirty whitish-yellow, the lines less distinct but the piliferous spots proportionately larger. Head quite variable in depth of shade.

Perfect Insect.—Average length 0.70 [inch, = 17.5^{mm}]; alar expanse 1.50 [inch, = 37^{mm}]. General color of fore wings very light pearly bluish-gray, with a perceptible deepening posteriorly. Quite variable, sometimes of a more decided blue, at others inclining to buff as in *Leucania unipuncta*, Haw. Markings, when distinct, as in Plate 1, Figures 5 and 6. With the exception of the reniform spot and subterminal line, however, they are usually distinct only on costa, being either indistinct or entirely obsolete on the rest of the wing. The subterminal line is light, with a more or less dark diffuse shade each side, which, in some instances, forms into sagittate spots. A black stain at the lower part of reniform spot forms a most distinctive character. Hind wings very pale and lacking the bluish cast of fore wings; lunule distinct, and a dark shade, enclosing a lighter mark, as in *Heliothis*, along posterior margin. Eyes dark; head and thorax same as fore wings; abdomen same as hind wings. The whole under surface the same as hind wings above, the lunules and arcuated bands faintly traced, the fore wings having a darker shade in the middle.

Described from 30 bred specimens.—[First Rept., pp. 78-79. Pl. 1, Figs. 5, 6.

AGROTIS COCHRANII, Riley.—*Imago*.—Fore wings of a light warm cinereous, shaded with vandyke brown and umber, the terminal space, except at apex, being darker and smoky. Basal, middle and limbal areas of almost equal width, the middle exceeding somewhat the others. A geminate dark basal half-line, usually quite distinct. Transverse anterior geminate, dark, somewhat irregularly undulate, and slightly obliquing outwards from costa to interior margin. Transverse posterior geminate, the inner line being dark, distinct and regularly undulate between the nerves, while the outer line is plain and much paler; it is arcuated superiorly and inversely obliques for two-thirds its width. Orbicular and reniform spots of normal shape, having a fine, dark annulation, which is however obsolete in both, anteriorly; the orbicular is concolorous with the wing, whilst the reniform has a dark inner shade with a central light one, and forms with the transverse posterior a somewhat oval spot which is also dark. Median shade dark and distinct interiorly, shading off and becoming indistinct in center of wing, and quite dark between the two spots, giving them a fair relief. Subterminal line single, light, acutely and irregularly dentate, with an inner dark shade, but warmer than that of terminal space. Terminal line very fine, almost black, slightly undulate. Fringes of same color as wing, with a light central line, having an outer dark coincident shade. A dark costal spot in basal area; at termini of the usual lines, and two light ones in subterminal space. In some specimens one or two fine dark sagittate marks are discernable, and also a fine black claviform mark. Hind wings: whitish, with a darker shade along posterior margin. Under surface of fore wings somewhat lighter than the upper surface and pearlaceous interiorly, with a smoky arcuated band—more definite near the costa than elsewhere—and a tolerably distinct lunule. Under surface of hind wings concolorous; slightly irrorate with brown anteriorly and posteriorly, and with an indistinct lunule and band. Antennæ, prothorax, thorax, tegulæ and body of same color as primaries, the prothorax having a darker central line, and in common with the tegulæ a carneous margin. Under surface lighter; legs with the tarsi spotted.

This moth, in its general appearance, bears a great resemblance to *Hadena chenopodii*, but the two are found to differ essentially when compared. From specimens of *H.*

chenopodii, kindly furnished me by Mr. Walsh, and named by Grote, I am enabled to give the essential differences, which are: 1st. In *A. Cochranii*, as already stated, the middle area exceeds somewhat in width either of the other two, while in *H. chenopodii* it is but half as wide as either. 2d. In the *Agrotis* the space between the spots and between the reniform and transverse posterior is dark, relieving the spots and giving them a light appearance, whilst in the *Hadena* this space is of the same color as the wing, and the reniform spot is dark. The claviform spot in the *Hadena* is also quite prominent, and one of its distinctive features, while in the *Agrotis* it is just about obsolete.

There are specimens that seem to be intermediate between these two, but all those bred by me, both male and female, were quite constant in their markings, and their intermediates will doubtless prove to be distinct species or mere varieties.

Larva—Length 1.07 inches [= 26.8^{mm}]. Slightly shagreened. General color, dingy ash-gray, with lighter or darker shadings. Dorsum light, inclining to flesh color, with a darker dingy line along its middle. The sides, particularly along the sub-dorsal line are of a darker shade. On each segment there are eight small, black, shiny, slightly elevated points, having the appearance of black sealing-wax, from each of which originates a small black bristle. The stigmata are of the same black color, and one of the black spots is placed quite close to them anteriorly. Head shiny and of the same dingy color as the body, with two darker marks, thick and almost joining at the upper surface, becoming thinner below and diverging toward the palpi. The upper surface of first segment is also shiny like the head. Ventral region of the same dingy color, but lighter, having a greenish tinge anteriorly and inclining to yellow under the anal segment. Legs of same color. It has a few short bristles on the anterior and posterior segments.

Chrysalis.—Length 0.70 of an inch [= 17.5^{mm}]. Light yellowish brown with a dusky line along top of abdomen. Joints, especially of the three segments immediately behind the wing-sheaths, dark brown. The brown part of these three segments, minutely punctured on the back. Eyes dark brown, and just above them, a smaller brownish spot. Two quite minute bristles at extremity.

Described from numerous bred specimens. — [First Rept., pp. 75-76. Fig. 26.

There is little question but that this is the moth briefly characterized by Harris (Ins. Inj. to Veg., p. 444) as *Agrotis messoria*, an examination of the types confirming this view. *A. repentis* G. & R. and *A. lycarum* are also conceded by Grote to be synonyms.

PLUSIA BRASSICÆ, N. Sp. — *Larva*—Pale yellowish translucent green, the dorsum made lighter and less translucent by longitudinal opaque lines of a whitish-green; these consist each side, of a rather dark vesicular dorsal line, and of two very fine light lines, with an intermediate broad one. Tapers gradually from segments 1-10, descending abruptly from 11 to extremity. Piliferous spots white, giving rise to hairs, sometimes black, sometimes light colored; and laterally a few scattering white specks in addition to these spots. A rather indistinct narrow, pale stigmatal line, with a darker shade above it. Head and legs translucent yellowish-green, the head having five minute black eyelets each side, which are not readily noticed with the naked eye. Some specimens are of a beautiful emerald-green, and lack entirely the pale longitudinal lines. Described from numerous specimens.

Chrysalis—Of the normal *Plusia*-form, and varying from yellowish-green to brown.

Moth—*Front wings* dark gray inclining to brown, the basal half line, transverse anterior, transverse posterior, and subterminal lines pale yellow inclining to fulvous, irregularly undulate, and relieved more or less by deep brown margins; the undulations of the subterminal line more acuminate than in the others, and forming some dark sagittate points; the basal half-line, the transverse anterior near costa, and the transverse posterior its whole length, being sometimes obscurely double: four distinct equidistant costal spots on the terminal half of wing, the third from apex formed by

the termination of the transverse posterior; posterior border undulate with a dark brown line which is sometimes marked with pale crescents; a series of similar crescents (often mere dots) just inside the terminal space; the small sub-cellular silver spot oval, sometimes uniformly silvery-white but more often with a fulvous centre, sometimes free from, but more often attached to the larger one which has the shape of a constricted U, very generally with a fulvous mark inside, which extends basally to the transverse anterior at costa. Fringes dentate, of the color of the wing, and with a single undulating line parallel to that on the terminal border. *Hind wings* fuliginous, inclining to yellowish towards base, and with but a slight pearly lustre; fringes very pale with a darker inner line. Under surfaces pale fuliginous with a pearly lustre, the front wings with a distinct fulvous mark under the sub-cellular spots, speckled more or less with the same color around the borders of the wing, the fringes being dentate with light and dark; the hind wings speckled with fulvous on their basal half, and with the fringes as above. *Thorax* variegated with the same color as front wings, the tufts being fulvous inclining to pink. *Abdomen* ♀ gray, with a few pale hairs near the base, and scarcely extending beyond the margin of the hind wings; ♂ longer, covered with pale silky hairs, a distinct dorsal brown tuft on each of the three basal segments, and two large lateral either fawn-colored or golden-yellow brushes on the fifth segment, meeting on the back and partly covering two smaller brushes on the sixth, which are tipped with black; terminal segment flattened and with two lateral more dusky and smaller tufts: underside of thorax and abdomen gray, mixed with flesh-color. Alar expanse 1.55 inches. Described from numerous bred specimens. In a suite of specimens bred from the same brood of larvæ a considerable difference in the general depth of color is found, some being fully as dark again as others.

Closely resembles *Plusia ni*, Engr., which occurs in Italy, Sicily, France, and the northern parts of America. Mr. P. Zeller of Stettin, Prussia, to whom I sent specimens, considers it distinct however from the European *ni*, and I have consequently given it a name in accordance with its habits. — [Second Rept., pp. 111–112. Fig. 81.

Notwithstanding its close resemblance to *ni*, the best authorities agree with Zeller in considering it distinct, as it certainly is. Strangely enough this same *brassicæ*, or what is extremely close to it, occurs also in South Europe and is figured in Stainton's *Entomologist's Annual* for 1870 as *P. ni*, one specimen having been found on the south coast of England, which specimen Zeller, as he wrote me, believes to have come from America. Standinger would probably characterize *brassicæ* as a "species Darwiniana," and there are doubtless individuals of both the species which approach each other so closely as to be undistinguishable. There is such variation in the silver spot in either that it cannot be depended on alone, but Speyer (*Europäisch-Americanische Verwandtschaften; Stettiner Ent. Zeit.*, June, 1875, p. 165) has presented other differences that are constant in detail, the most noticeable of which are the darker and more irrorate coloring and the interrupted and wavy terminal line of *brassicæ*, against the paler, smoother, more metallic coloring and the perfectly straight and unbroken terminal line of *ni*.

The larva is the most common cabbage pest in the Southern States, and is infested with an undetermined parasite. Mr. E. A. Popenoe has found it feeding on the leaves of *Crepis*, and what appears to be the same has been found by my assistants on Clover, Dandelion, *Senecio scandens*, and *Chenopodium*.

APLODES RUBIVORA, N. Sp. — *Larva* — Average length 0.30 inch [= 20^{mm}]. Color light yellowish-gray, darker just behind each joint, and very minutely shagreened all over. On each segment a prominent pointed straight projection each side of dorsum, and several minor warts and prickles below. Two very slightly raised, longitudinal lighter lines along dorsum, between the prominent prickles. Ten legs.

Perfect insect — Alar expanse 0.50 inch [= 12.5^{mm}]; length of body 0.25 inch [= 6^{mm}]. Color verdigris-green, the scales being sparse so that the wings appear sub-hyaline. Fore-wings with two transverse lighter lines dividing the wing into three parts, proportionate in width as 3, 4, 2 counting from base, and parallel with posterior margin; also a faint line between these two, running to about $\frac{1}{2}$ of wing from costa. Hind wings with two similar transverse lines, dividing the wing in like proportion, the outer line not parallel with margin, but wavy and produced posteriorly near its middle. Costa pale; fringes obsolete. Head, thorax and abdomen green above, but, together with antennæ and palpi, white beneath.

Described from one ♀ specimen. — [First Rept., pp. 133-140. Pl. II, Fig. 25.

Dr. Packard, in his *Monograph of the Geometrid Moths, etc.* (U. S. Geol. Surv. of Terr., Vol. X, 1876, p. 382), refers it to the genus *Synchlora* Gor., and adds the conventional ending to the specific name, so that the species becomes *Synchlora rubivoraria*. *Synchlora albolineata* Pack. and *Eunemoria gracilaria* Pack. are given as synonyms.

PHYCITA [*ACROBASIS*] *NEBULO*, Walsh — *Imago*. — I reproduce here the description of the moth in Mr. Walsh's original words: "Expansion of wings 7-10. Length of body 3-10. General color light cinereous, varied with dusky. A row of about seven sub-semilunar or linear dark spots on outer margin of fore wing. Then one-fourth of the distance to the body a waving light cinereous band parallel to the exterior margin, marked on each side with dusky black. Nearly at the centre a much abbreviated black band. Beyond the centre on the costal margin a subtriangular dusky black spot, the apex of which connects with the apex of a much larger subobsolete triangular brick-red spot which extends to the interior margin, and is bounded on the outside by a wavy light cinereous band, which is again bounded by a wavy dusky black band proceeding from the apex of the costal triangle. Base of wing dusky black, inclosing a small round light cinereous spot. Hind wings and all beneath light cinereous shaded with dusky, the fore wings darker. Tarsi dusky with a narrow light cinereous fascia at the apex of each joint. Hind tibia fasciate with dusky at the apex, sometimes obscurely bifasciate. Intermediate tibia fasciate with dusky at the centre, the fascia generally extending to the base, but becoming lighter. Anterior tibia dusky, with a narrow apical light cinereous fascia. Palpi, both labial and maxillary, dusky."

When compared with other closely allied and resembling species, this little moth may be characterized in the following manner: The ground color of the front wing is decidedly bright and pale; the discal spots are almost always confluent, thus forming an abbreviated transverse bar; the dark markings are well defined and the triangular dark costal spots starting from the inner third of the wing is distinctly relieved, while the "brick-red" (nearer a cinnamon-brown) triangular spot which opposes it is large, so that the space it occupies on the inner margin is nearly as wide (generally within one-third) as that between it and the transverse posterior line. The lower half of the basal space is often of a distinct cinnamon-brown, and an oblique dusky band, which Mr. Walsh has not mentioned, is often quite distinct, running from near the apex to the brown triangle, where it connects with the inner margin. The species recalls, in facies, the European *Myelois suarella*. In a suite of specimens bred from Apple, Quince, Plum and Cherry, there is sufficient variation to prevent a too rigidly drawn description, but the above characters obtain in all of them, and such variation as occurs runs in the direction of the variety presently to be described.

Larva — [Length 0.5 inch] Brown or greenish in color. Cylindrical. Tapering grad-

ually from first to last joint. Head and cervical shield darker than the rest of body, slightly shagreened, sparsely covered with long hairs, the shield quite large, convex, and occupying the whole surface between stigmata—there being in front of the latter a sub-cervical dark horny plate. Joints 2 and 3 wrinkled as at Fig. 18, *c* the former with two rather conspicuous dark dorsal piliferous spots. The other joints with a few fine hairs, the stigmata plainly visible, and the anal covering but slightly horny. Legs and prolegs of moderate size and of same color as body.

Described from numerous specimens.

Chrysalis—Mahogany-brown, with no striking character. Abdomen, especially above, with very minute punctures.

VARIETY NEBULELLA (Fig. 20, *e*).—I have bred a single specimen from wild Crab (*Crataegus*) which differs in some essential features from the normal form, but which nevertheless can only be considered a variety of it, as I observed no larval differences. It differs in the more uniform and subdued tone of the front wings, the markings being more suffused and indistinct; but principally in the relative narrowness of the space outside the transverse posterior line the greater consequent width of the middle area, and smallness of the triangular brown spot—the space it occupies on the inner margin being scarcely one-half as wide as that between it and the transverse posterior line. The discal spots are also separated.

Described from one good specimen. An interesting fact connected with this variety is, that precisely the same form occurs in Europe, as I found a single specimen in the cabinet of M. J. Lichtenstein of Montpellier, France, which he had captured in that vicinity, and which he allowed me to bring home for comparison. It seems to be rare, even there, and whether indigenous or imported from this country, is a question yet to be solved.—[Fourth Rept., p. 41–42, Figs. 18, 19, 20.

ACROBASIS JUGLANDIS, LeBaron.—(Fig. 20, *d*)—I have bred this species from Hickory, but as Dr. LeBaron has also bred it abundantly from Walnut, and has signified his intention of describing it in his second annual Report, I adopt his proposed name, and shall content myself with pointing out the manner in which it may generally be distinguished from *nebulo*. Firstly, by the paler basal area of the front wings, which is sometimes almost white, especially near the costa, and by the head and shoulders and sometimes the ♂ antennal horn partaking of this paler color. Secondly, by the darker median space, the dark triangular costal spot not being well relieved posteriorly, but extending so as sometimes to darken the whole space. Thirdly, by the discal spots always being well separated.

Such are its specific characters as taken from 3 hickory-bred and 6 walnut-bred specimens; but of the former there is 1 which when placed alongside of some of the more abnormal specimens of *nebulo*, can scarcely be distinguished from them, and, if chosen without knowledge of its larva, would certainly be placed with them; while of the latter there are two which nearly as closely resemble the variety *nebulella*. In general characters, in the size of the brown triangular spot, and the manner in which the inner margin is divided, *juglandis* is intermediate between *nebulo* and *nebulella*. In one of the hickory-bred specimens, the general color is quite warm, and the basal area caraneous rather than white.—[Fourth Rept., p. 43. Fig. 20, *a*, *b*, *d*.

Dr. LeBaron published his description of it about the same time, under the name *Phycita juglandis*, in his Second Report on the Insects of Illinois, p. 123.

PEMPELIA HAMMONDI, N. Sp. *Imago* (Fig. 21, *d*).—Average expanse 0.48 inch [= 12^{mm}]. Front wings glossy purplish-brown with two silvery gray transverse bands dividing the wing on costa in about three equal parts, the basal band sharply defined outwardly and always extending to inner margin, the posterior band never extending more than half way across the wing, and generally not more than one-third, illy defined. In some specimens the basal transverse band is quite narrow, with the basal space a shade paler than the median: in others the band forms a double line. In some

specimens also, a narrow pale transverse line outside the second hand, and a pale terminal shade, are visible. Hind wings uniformly paler gray. Under surface glossy gray, with no marks, the front wings a shade darker than the hind. ♂ differs from ♀ in the basal portion of the antennæ being curved, and the curve filled with a tuft of scales.

Described from numerous bred specimens. The species has the general facies of the European *Cryptoblabes biatruga*, which is a larger insect.

Larva.—Length 0.45–0.50 inch [= 11–12.5mm]. General color olive, or pale green, or brown, with a broad dark stripe along each side of back. Tapers slightly both ways, joints 4-12 inclusive, divided into two transverse folds. Freckled with numerous pale specks and with piliferous spots, the specks often taking the form of two pale broken lines along the upper edge of dark stripe. The piliferous spots are pale with a central black dot, and are best seen in the dark specimens. On joints 4-12 inclusive they are placed 4 in a square on the middle of the back, and four more each side, the two upper lateral ones being on the anterior fold, the stigmata appearing as minute rufous specks between them. Both these spots are often double. The third lateral spot is on the posterior fold and the fourth is subventral and anterior. The hairs proceeding from these spots are long and setaceous. Head horizontal, freckled, pale behind, tinged with green in front and with a few long hairs. Joint 1 also freckled and with a large black piliferous tubercle with a pale basal annulation and in range with middle of dark stripe. Joint 2 with similar black tubercles with a white centre and replacing the uppermost lateral pale spot. There are but two of the small pale dorsal piliferous spots on this joint (between the tubercles) as well as on joint 3. Beneath immaculate, except that the thoracic legs have sometimes a few dusky dots.

In the very dark specimens the head, cervical shield and anal plate remain pale. The cervical shield is then well defined with four small piliferous specks at anterior edge, and the large shiny tubercle forms the extreme anterior angle.

Described from numerous specimens.

Pupa.—0.24 inch [= 6mm] long; rather stout and short, with two minute diverging spines and a few stiff bristles at tip.

In many specimens the subdorsal dark stripe is obsolete or sub-obsolete, but even then the four black tubercles on joints 1 and 2 characterize the larva sufficiently.—[Fourth Rept., p. 46. Fig. 21.

TORTRIX RILEYANA, Grote—*Larva*—Length, Hickory feeding, 0.60-0.80 inch [= 15–20mm]; Snowberry feeding, 0.40-0.50 inch [= 10–12.5mm]. Largest on segment 2, tapering thence gradually to anus. Ground color dull yellow. Covered with large, distinct, black, sealing-wax-like, slightly elevated spots, each giving rise to several fine bristles. These spots are thus arranged on each segment: 2 each side of dorsum the posterior ones widest apart; 1 at sides in the middle of the segment, containing the stigmata in its lower hind margin; 1 smaller and narrower just below this, on a somewhat elevated longitudinal ridge, and 1 round one below this ridge on the posterior part of the segment. Segments 2 and 3 have but one spot each side of dorsum. Two distinct wrinkles on all the segments, more on 2 and 3. Head, cervical shield, and caudal plate black. Venter dirty yellow with black marks; legs ditto.

Chrysalis—Honey-yellow, robust in the middle, and with two transverse rows of minute teeth across the back of each segment.

Perfect Insect—From Hickory—Average expanse 1 inch, length of body, 0.35 [= 8.8mm]. Deep ochreous. Fore wings evenly washed with purplish, leaving the fringes and costal edge dark ochreous. The markings take the shape of dark velvety brown rounded maculations, generally of small size and faintly shaded with ochreous on the edges. Three of these subterminally at the base of the wing, subequal, situated interspaceally between the nervures. At a little within the middle of the costa are two fused maculations, the most prominent. Before and beyond these, some faint costal marks. At the extremity of the discal cell, above median nervure, is the first of a

series of maculations, normally four in number but not constant, usually uneven in size. A subterminal series of spots is inaugurated on costa by a large, compound shaded maculation. Below this, over the median nervules, sweeps an outwardly rounded series of small approximate dots. Two dots on costa, within and at the apex, and a faint terminal series of minute streaks is shortly discontinued. Hind wings of a lustrous bright deep ochreous; pale along the costal margin and darker shaded along internal margin. Beneath, as are the hind wings above; both wings immaculate, fore wings the darker. Body and appendages concolorous, bright deep ochreous. Antennæ simple. Numerous bred specimens.

From Snowberry—var. symphoricarpi.—Much paler, the fore wings not being as dark as the hind wings of the above. The upper surface of fore wings not washed with purplish but merely of a darker ochreous than the hind wing. The maculations entirely similar but ferruginous, paler and the slighter costal marks obsolete. Legs at base and under thoracic surface almost whitish. Average expanse, 0.62 [=15.5^{mm}]; length of body, 0.30 [=7.5^{mm}]. Described from numerous specimens. Under surfaces exactly alike in both varieties.—[First Rept., p. 154. Fig. 85, and Pl. 2, Figs. 3, 4.

TORTRIX CINDERELLA, N. Sp.—*Imago*.—Alar expanse exactly 1-2 inch [=12.5^{mm}]. Front wings deep glossy ash-gray, immaculate. Under a lens they have an irrorate appearance, while in certain lights some of the scales appear to form a series of darker transverse sinuous lines. Also scattered over the wing may be noticed a dozen or more reddish scales, which are not sufficient, however, to destroy the uniform immaculate appearance. Head, mouth-parts, antennæ, legs, and abdomen of same color. Hind wings paler and semi-transparent. Fringes of all wings concolorous. Under surface of wings pale nacreous, inclining to pale fulvous around the margins.

Described from two bred specimens.

Larva (Fig. 22, a).—Length 0.50 inch [=12.5^{mm}]. Form of that of *Acrobasis nebulo*, wrinkled very much in the same manner. Color yellowish-green, the piliferous spots of the same color, but readily distinguished by their polished surface; they are placed in a transverse row on thoracic joints, and on joints 4—12 there are four trapezoidally on dorsum, two laterally on the first fold and one subventral. Stigmata between the two lateral spots, and yellowish. Head and cervical shield gamboge-yellow; only a shade darker than body; labrum and two basal joints of antennæ paler or white, the terminal joint brown; ocelli on a somewhat crescent-shaped black spot (the most conspicuous character) a second dusky spot at base of head laterally. Legs immaculate.

Described from many specimens.

Pupa (Fig. 22, b).—Length 0.25—0.30 inch [=6—7.5^{mm}]. Brown, characterized by a peculiar rounded projection from front of head; by a little pointed prominence at base of each antennæ, and each side of penultimate abdominal joint; and by terminating in a broad suppressed piece which produces two decurved hooks. Posterior rim of abdominal joints rasped dorsally, and a slight rasped dorsal ridge near the anterior edge of larger joints. Legs reaching only to end of wing-sheaths. The head-prominence varies in size and slightly in form.—[Fourth Rept., p. 47.

From specimens reared from cranberry-feeding larvæ received from Mr. Jno. H. Brakeley, of Bordentown, N. J., I am satisfied that this is the same species briefly characterized by Packard in the 1st edition of his *Guide* (p. 334) as *Tortrix oxycoccana*, and that *T. malivorana* LeBaron (my Rep. IV, p. 47) is but a dimorphic orange form, subsequently described by Packard as *T. vacciniivorana* (Hayden's Report of the U. S. Geol. and Geogr. Survey of the Territories 1878, p. 522). The orange and ash-gray specimens are thus bred both from Apple and Cranberry. I have reared both forms from Cranberry and from Apple, and they are undistinguishable in the larva and pupa states. The gray form is often

more or less suffused with orange scales and the orange form less frequently with gray scales. This is the most remarkable case of dimorphism with which I am familiar in the family, and points strongly to the important bearing of biological facts on a true classification. The dimorphic coloring is not sexual, but occurs in both sexes. The eggs of this species are very flat, circular and translucent, with a diameter of 0.7^{mm}, and are laid singly on the underside of the leaf near the mid rib. The species belongs to the genus *Teras*, and as Packard's specific name *oxycoccana* has priority, the insect should be known as *Teras oxycoccana*, Pack. The insect, according to Mr. Brakeley, who gives an account of it in the Report of the Seventh Annual Convention of the New Jersey Cranberry Association (1879, p. 7), commonly affects, also, the high-bush whortleberry. The gray form of the moth is most frequent in autumn.

GELECHIA GALLIESOLIDAGINIS, N. Sp.—*Larva*.—Length 0.60 [inch, = 15^{mm}]. Cylindrical. Color dark dull-brown, without shine. Largest on middle segments; tapering from 4th to head, and from 9th to extremity. Each segment impressed transversely in the middle, thus forming two folds, the thoracic segment having other such folds. Six small piliferous spots, two each side of dorsum and one above stigmata, which, together with the stigmata, are shiny and of a lighter brown than the body. Head and cervical shield light shiny-brown.

Chrysalis.—Length 0.50 [inch, = 12.5^{mm}]. Mahogany-brown. Form normal. Blunt at extremity.

Perfect moth.—Average length 0.38 [= 9.5^{mm}]. Alar expanse ♀ 0.95 [inch, = 24^{mm}], ♂ 0.75 [inch, = 18.8^{mm}]. Fore wings deep purplish-brown, more or less sprinkled with carneous. A light carneous band starts from the costa near the base, and curves towards the middle of the inner margin, which it occupies to a little beyond the beginning of the cilia, where it curves-upwards towards the tip, reaching only half way up the wing. Here it is approached from above by a somewhat diffuse spot of the same color, which starts from the costa just behind the apex, and runs down to the middle of the wing.

In the plainly marked individuals there is an extra line running from the middle of the inner margin, outwardly obliquing to the middle of the wing, and then back to the inner margin a little beyond where the cilia commences, but in the great majority of specimens this mark is indistinct. Cilia light carneous. Hind wings slate-gray, with the cilia lighter. Antennae finely annulated with the same two dark and light colors. Head, thorax and palpi light, with a sprinkling of the dark brown. Body dark, with light annulations. The species varies in the distinctness of its markings, and the light parts of the front wing appear finely sprinkled with brown under the lens. Male generally smaller than female, with the antennae proportionately a little longer.

Described from numerous bred specimens.

It seems to resemble *G. longifasciella* of Clemens, in coloration and pattern; but unfortunately our late lamented microlepidopterist, failed almost always to give the measurement of the species he described, and it is impossible to tell how much mine resembles that species. Yet, as *longifasciella* was described from two mutilated specimens, received from A. S. Packard, jr., and as that gentleman has seen my insect and declared it an undescribed species, there can be little doubt of the fact.—[First Rept., p. 175. Pl. II, Figs. 1, 2, 5.

PTEROPHORUS CARDUI, N. Sp.—*Larva*.—Average length 0.60. Largest in the middle of body, tapering thence each way. Color light straw-yellow—greener when young. Somewhat darker, partly translucent, dorsal, subdorsal and stigmatal lines. Two lateral rows of black spots, the lower spots rather smaller and placed behind the

upper ones. A third row above these, and others along the back, but so small that they are generally imperceptible with the naked eye, except on the thoracic segments, being especially distinct on segment 2. Head small, black, sometimes inclining to brown. Cervical shield black, divided longitudinally in the middle by a lighter line. Caudal plate also black. Segment 11, besides the spots above mentioned, has two transverse black marks, the posterior one the largest. Thoracic legs black, the others of the same color as the body.

Described from 12 specimens.

Pupa.—Average length 0.45. Of form of Plate 2, Fig. 14. Soft, dull yellow, with a lateral dusky line each side of dorsum, and another, less distinct, each side of venter. Also dusky about the head and wing-sheaths.

Perfect insect.—Length 0.45; alar expanse 0.80. Front wings bifid, the cleft reaching not much more than $\frac{1}{2}$ of wing; tawny yellow, with a distinct dark brown triangular spot running from costa to the base of cleft—sometimes a little below it—its posterior margin with a slight concave curve. Three dusky, diffuse longitudinal spots, one placed on the basal third of the wing at costa and frequently reaching along the costa to the triangular spot; one near the interior margin, a little nearer to the base of wing than the last, and one on the outer third of the interior margin. Two light-colored transverse lines across the end of wing, one very near and parallel with posterior margin, the other bordering the triangular spot behind, and curving across the lower lobe towards posterior angle. The space between these two light lines usually darker than the ground-color. Fringes dark with a light margin. Hind wings trifid, the upper cleft reaching a little beyond the middle, the lower one to the base of wing. Color ashy-brown, the lower lobe produced into a dark angular spot about their middle posteriorly. Antennæ, palpi, head, thorax, and body, tawny yellow; legs of the same color with the exception of the tarsi, which are almost white, with alternate dark brown spots, the spines being black, with dusky tips.—[First Rept., pp. 180–181. Fig. 98, and Pl. II, Figs. 13, 14.]

Zeller has since (1872) referred it to the genus *Platyptilia* (Beitr. zur Kenntn. N. A. Nachtfalter, 2nd part, p. 118), and indicates the difference between it and a very closely allied European species, *P. Zetterstedtii*. He very properly, because of the incongruous compound, drops the conventional ending *dactylus* which I used in the original description.

HETEROPTERA.

NYSIUS DESTRUCTOR, N. Sp.—General color grayish-brown; of shape of *N. thymi* Wolff. Head either minutely or more coarsely punctate, and more or less distinctly pubescent; the surface usually brown, with a distinct black, longitudinal line each side, broadening on the crown, but generally leaving the orbit of the eyes pale; these lines sometimes more diffuse and occupying the whole surface, except a median brown spot at base of crown, and a narrow, paler spot on the clypeus; ocelli piceous; eyes opaque, either black or slate-color; face sometimes uniformly pubescent and appearing dark grayish-brown; but more generally black each side of rostrum, with a distinct yellowish-brown spot on the cheeks below the eyes; rostrum piceous, paler at base and reaching to hind coxæ; antennæ either pale yellowish-brown or darker brown, the torulus and first joint darkest. Thorax, pronotum narrowing anteriorly, the sides slightly sinuate, irregularly and more coarsely punctate than the head, more or less pubescent, dingy yellow or brown, with a transverse black band near the anterior edge, obscuring the incision and leaving the edge pale, especially in the middle, where there is often a conspicuous pale spot; also five more or less distinct longitudinal dark lines, the central one most persistent and leading on the posterior margin to a pale, shiny, impunctate spot; the callus at hind angles, and sometimes an intermediate spot between it and the median one, and the entire posterior margin, also pale and impunctate; scutellum dark, coarsely punctate, sometimes with a smooth median lon-

gitudinal ridge ending in a pale spot, and with the lateral margins pale; prosternum dark, more or less pubescent, the anterior and posterior margins, and a band outside of coxæ, more or less broadly pale; mesosternum and metasternum also dark, with the pale spots outside of coxæ. *Legs* pale yellow, inclining more or less to brown; coxæ dark at base, pale at tip; trochanters pale; front and middle femora spotted more or less confluent on the outside with brown; hind femora, ♂ dark brown, except at tips and base; ♀ spotted only; tibiæ ringed with brown at base; tarsi marked more or less with brown, especially at tip. *Hemelytra* either colorless, transparent and prismatic, or distinctly tinged with dingy yellow; shallowly punctate and very finely pubescent, the veins of corium and clavus dingy yellow, with brown streaks, the more constant of these streaks being two on posterior margin of corium, and one at the tip of clavus. *Abdomen*, ♂ tergum piceous, with the sutures and sides of some of the joints rarely paler; venter piceous, minutely and regularly covered with gray pubescence; ♀ sutures and spots on tergum more often pale; venter dingy yellow, except at base; ♀ paler than ♂, and generally larger. Average length 0.13 inch [= 3.3^{mm}].

Larva.—Dingy yellow, with more or less distinct longitudinal dark lines, especially on head.

Pupa.—Same color, with more distinct red and brown longitudinal lines, and two little tooth-like, pale yellow processes at inner base of hemelytra pads, indicating the wings; the abdomen paler than the rest of the body.

Described from numerous specimens. I have some, especially males, in which the black so predominates that the paler parts of the head and thorax are scarcely traceable, while in others again the pale parts predominate almost to the exclusion of the black. Indeed, so variable is the species that it is difficult to see wherein some of the specimens differ from the European *thymi*, or from *N. angustatus* Uhler, and it is barely possible that future comparison will show specific identity between some or all of the three. But as long as authors fail to give the variation a species is liable to, or the number of specimens a description is drawn up from, it will remain impossible to decide such questions satisfactorily, and I name *destructor* at the suggestion of our Hemipterist, Mr. P. R. Uhler, of Baltimore, who has examined specimens which I sent him.—[Fifth Rept., p. 113. Fig. 41.]

MYTILASPIS POMICORTICIS, N. SP.—*Eggs*—from 30 to 100 under each scale; length scarcely 0.01 inch, irregularly ovoid, nearly thrice as long as wide, snow-white, except just prior to hatching, when they become yellowish. *Larva*.—Length of body 0.01 inch, ovoid, thrice as long as wide, pale yellow, with a darker yellow spot near each end; a few short hairs seen around border; two fine anal setæ about half as long as body springing from two lobes between which two spinous hairs are always seen; antennæ quite variable, the joints irregular and not easily resolved, sometimes appearing only 6-jointed, but more generally 7-jointed, with a few hairs, two or three at tip the longest and most persistent; legs with a one-jointed tarsus, a feeble claw, and, among other hairs, four more or less distinctly knobbed ones near tip, the two uppermost longest.

♂—Length of body, 0.022 inch [= .55^{mm}]; color, translucent carneous-gray; a dorsal transverse band on each abdominal joint, and portions of the mesothorax and metathorax darker, or purple-gray; the members somewhat lighter. *Head*, sub-triangular; rostrum rudimentary; ocular tubercles, one each side of it, plainly visible, the eyes on the upper surface prominent, dark, and with few facets; antennæ as long as body, 10-jointed, joints 1 and 2 bulbous and sometimes indistinctly separated; 3—9 about four times as long as wide, slightly constricted; 10 half as long and fusiform; all but basal two with a whorl of about eight hairs, slightly clavate and as long as width of joint. *Thorax* very large, oval; prothoracic portion narrowing in front, composed of two transverse folds, the anterior one having a transverse row of four dusky dots; the mesothoracic portion large and elevated, showing three lateral swellings; a well-defined medio-dorsal plate, rounded in front, shallowly-notched behind, with a medio-

longitudinal suture, and a transverse one dividing it in two, the anterior half pale, the posterior darker; the metathoracic portion showing a sub-triangular scutell, and separated from mesothorax by the transverse band (*apodema* of Targioni). *Wings* about as long as body, arising from base of mesothorax, spatulate, closing flat on back in repose, and appearing whitish, finely and uniformly covered with short, stiff hairs; supported by a bifurcate vein, the bifurcation arising from basal fourth, and each fork running near and almost parallel with the wing-margins; balancers dark, with the hook quite long. *Legs* with the middle pair longest, and—from large size of coxæ—further from front than from hind pair; the coxæ and femora large and swollen, the latter with a more or less distinct lobe near the base below; the tarsi one-jointed, with a constriction occasionally indicated, and terminating in a single flexible claw, surrounded by four clubbed hairs; the tibiæ and tarsi are quite bristly, but on the femora there are usually but two bristles, one about the middle above, and one on the basal lobe below; the coxæ also have one above. *Abdomen*, seen from above, nearly as long as thorax; appearing shorter from below; 8 joints only discerned; the last joint abruptly narrowed into a large tubercle bearing four bristles on the under side, and sending forth the genital armor in the form of an awl-shaped style as long as the abdomen.

♂ *Scale*—Larval part golden yellow; the anal shield yellowish-brown, sometimes quite pale, inclining to white, flattened, straight, rather more than twice the length of larval scale, increasing in width from tip to end, where it is slightly truncate; attached by a white film; average length, 0.035 inch.

♀—Average length, 0.05 inch; color, pale yellow; jug-shaped and flattened when young, more globular when mature, and twice as long as wide; the cephalo-thoracic portion rounded and entire, but narrower than the abdominal, at the juncture with which it forms a more or less conspicuous lateral projection; on its inferior side is a tubercle, having two longitudinal ridges, and giving rise to a corneous, filiform proboscis, longer than the body, and composed of four separate parts; posterior abdominal joints deeply lobed laterally, with two or three blunt, fleshy hairs to each lobe; anal plate gamboge-yellow, corneous, with an irregular border, presenting two larger, slightly tri-lobed, median projections, and one or more smaller ones each side, furnished with spinous hairs, two especially between the tri-lobed projections aforementioned; five more or less complete sets of secretors visible from below, arranged around anus in form of an arc, the median set with normally 10, the upper laterals 20, and the lower laterals 14; besides these, some six or more blunt tubes, and a series of shorter pointed ones, may be noticed along the border, and doubtless serve as secretors. (See Fig. 32 b.)

♀ *Scale*—Larval scale golden-yellow; median scale somewhat darker; anal shield varying from pale brown to deep purplish-gray, and generally of a color with the bark it is upon. The whole scale is often incanous, but the hoary film easily rubs off; it averages 0.12 inch in length, but is quite variable in form and size, being either straight or curved, narrow and strongly arched, or broad and flatter, but always rounded at the end; the white inferior laminae at sides sometimes show distinctly from above, and give the appearance of a pale border.

The lice, whether ♂ or ♀, vary in appearance according to position and state of maturity. In making the foregoing descriptions and figures, I have taken what appeared the most natural positions, after examination of many specimens. The ♂ abdomen shrinks very much in drying, and the more detailed ♀ characters are variable. While the normal number of secretors in the middle set is never more than 10, I have sometimes found but 8 or 9; that of the upper laterals never surpasses 20, but may be as low as 15; while that of the lower laterals is more uniformly 14, though I have sometimes found 16, and at others 12. Opposite sets do not always contain the same number.—[Fifth Rept., pp. 95-96. Figs. 31, 32.]

This is the species previously known as *Aspidiotus conchiformis*, or popularly as the Oyster-shell Bark-louse, and the reasons for separating it are given in the report.

ERIOSOMA ULMI, N. Sp.—Color dark blue. Length to tip of closed wings, exclusive of antennæ, 0.12 [inch, = 3^{mm}]. Wings hyaline, three times as long as wide, and more pointed at the ends than in *E. pyri*. Costal and subcostal veins, and that bounding the stigma behind, robust and black. Discoidal veins together with the 3d forked and stigmal veins, all slender and black, the forked vein being as distinct to its base as are the others, with the fork but $\frac{1}{2}$ as long as the vein itself and curved in an opposite direction to the stigmal vein. Antennæ 6-jointed and of the same color as the body; joints 1, 2, 4, 5 and 6 of about equal length, joint 3 thrice as long as either. Legs of the same color as body.

The young lice are narrower and usually lighter colored than the mature individuals, varying from flesh or pink to various shades of blue and purple.—[First Rept., p. 124.

Professor Thomas (Trans. Ill. St. Hort. Soc., 1876, p. 191) has called it *Erisoma Rileyi** because of *ulmi* being preoccupied by an European species. It belongs to *Schizoneura*. For subsequent remarks see "Notes on the Aphididæ of the United States, etc., by C. V. Riley & J. Monell," (Bull. Hayden's U. S. Geol. & Geogr. Survey, Vol. V, No. 1, p. 3.)

DIPTERA.

ASILUS MISSOURIENSIS N. Sp.—Alar expanse 1.85 [inches, = 47^{mm}]; length of body 1.30 inches [= 33^{mm}]. Wings transparent, with a smoky yellow tinge, more distinct around the veins, which are brown. Head pale yellow, sometimes brownish; moustache straw-yellow with a few stiff black hairs below; beard pale straw-yellow; crown very deeply excavated; base of the same pale yellow with short, stiff, yellowish hairs, and a crown of black ones near the border; eyes large, prominent, finely reticulated and almost black; antennæ, first joint black tipped with brown, cylindrical and hairy; second joint black, short, thick and rounded at tip, with a few stiff hairs; third joint as long as first, tapering each way, smooth, black and terminating in a long, brown bristle; proboscis black and nearly as long as face; neck with pale and black hairs. Thorax leaden-black, slightly opalescent with reddish brown at sides, more or less pubescent with pale yellow, especially laterally and posteriorly and in three narrow longitudinal dorsal lines which gradually approach towards metathorax; bearded at sides and behind with a few decurved black bristles, those behind interspersed with a few smaller pale hairs; scutell of the same color, with upward-curving, black bristles; halteres brown. Abdomen, ♂, general color dull leaden-yellow, with darker transverse bands at intersections; the light color produced by a yellowish pubescence and numerous short close-lying yellow hairs, the dark bands produced by the absence of this covering at the borders of each segment; basal segment broad, bilobed, and with lateral black bristles; segments 6, 7, 8 and anal valves with a decided pink tint, especially 7; 8 but one-third as long as 7 above. ♀, broader, flatter, more polished and brassy, with no transverse darker bands, segments 7 and 8 polished black, the latter narrow and longer than any of the others; anus with a few black bristles. Legs, dull purple-brown, with black bristles; thighs very stout, the hind pair rather darker than the others, the two front pair of trochanters with long, yellowish hairs; pulvilli, generally fulvous.

Described from two ♂, and two ♀, all captured while sucking honey-bees. I have not access to Loew's descriptions, and cannot therefore compare it with already described species; but specimens have been sent to Dr. Wm. LeBaron, of Geneva, Illinois, and to Baron Osten Sacken, of New York, and both these gentlemen are unacquainted with it, and believe it to be new. In the well marked ♂ specimens, the body bears a general resemblance to that of *Trupanea* [*Promachus*] *vertebrata*, Say.—[Second Rept., pp. 122-123. Fig. 89.

* By typographical error *Rilepi*.

Baron Osten Sacken has since placed this as a synonym of *Proctacanthus Milbertii* Macq. in the second edition of his Catalogue of the described Diptera of North America (1878), p. 81.

LYDELLA DORYPHORE, New Species.—Length 0.25 [=6mm]. Alar expense 0.48 [=12mm]. Antennæ black. Palpi fulvous. Face silvery white. Front silvery, tinted with pale golden-brown, with a broad middle stripe black. Thorax cinereous with imperfect black stripes. Abdomen black and silvery-ash, changing into each other when viewed from different angles. When viewed from above: first segment deep black with a posterior border of silver-ash very narrow in the middle, much widened laterally, but abbreviated at the sides of the abdomen. The other segments with the basal half silvery-ash, terminal half black. Legs black. Fourth longitudinal vein of the wings straight after the angle. Posterior transverse vein arcuate.

Described from numerous bred specimens.—[First Rept., pp. 111-112. Fig. 48.]

This species is referred by Osten Sacken to the genus *Exorista* of Schiner, *Lydella* not being received as a distinct genus. The name *Lydella* is used also for a genus of Acarina.

EXORISTA FLAVICAUDA, N. Sp.—Length 0.35 to 0.50 inch [=8.5-12.5mm]. Head broader than thorax; face, silvery-white, the cheeks inclining to yellow, with lateral black hairs extending to near the base of antennæ, and one stiffer and longer bristle at top of cheeks; front, dusky, ferruginous, with two rows of black converging bristles; divided by a broad depressed stripe of a brighter ferruginous color and without bristles; occiput bright ferruginous; labium ferruginous with hairs of same color; maxillæ rufous; eyes dark mahogany-brown, and perfectly smooth; antennæ, two basal joints rufous, with black hairs, third joint flattened, dusky, and thrice as long as second; seta, black; entire hinder part of head covered with dense white hairs. Thorax, more decidedly blue than in *leucanæ*, broader (instead of narrower) in front than behind; the vittæ less distinct; scutellum of same color as thorax. Abdomen, stout and more cylindrical than in *leucanæ*; first joint dark bluish-gray; second, light bluish-gray, becoming darker along the middle, at sides and at lower border; third joint, like second above, but golden-gray at sides (no rufous); last joint entirely yellow or pale orange, with no other color and but few black bristles around anus. Wings more dusky than in *leucanæ*; alulae, opaque bluish-white. Legs, black; pulvilli pale yellow.

Described from one captured, 4 bred ♀. Space between eyes at occiput fully one-third the width of head.—[Second Rept., pp. 51-52. Fig. 18.]

TACHINA [*EXORISTA*] *PHYCITÆ*, LeBaron.—*Imago*.—Length, 0.20 inch [=5mm]. Antennæ black, third joint twice as long as the second; face silvery, without bristles at the sides; sides of the front silvery at the lower part, pale golden above; the middle black vitta occupying a little more than half of the width of the inter-ocular space; frontal bristles continued down the face to opposite the end of the second joint of antennæ; palpi blackish-brown; eyes hairy. Thorax black, with the ordinary cinereous stripes scarcely perceptible. Abdomen black, varied with cinereous at the base of the segments; a large fulvous spot on the side of the abdomen occupying nearly the whole of the side of the second segment, half or more of the third, and sometimes a small spot on the first; bristles on the middle as well as at the hind-margin of the second and third segments. Venation of the wings of the usual type; first posterior cell almost closed, before the end of wing; fourth long vein slightly curved after the angle; fifth long vein prolonged to the margin; hind cross vein moderately sinuous. Tarsal claws and pulvilli unusually long.

Female? A single specimen, a very little larger than the others, was obtained from the same lot of leaf-crumplers, which possibly may be the ♀ of the same species. It differs as follows: Front broader; antennæ dark brown; the cinereous markings of the body more distinct; the tip of abdomen fulvous, but without the fulvous spot at the sides; and with the tarsal claws of ordinary length.

This species appears to belong to the subgenus *Exorista* of Meigen, closely allied to *Tachina* proper, and differing from it chiefly in having the eyes hairy, and in the presence of bristles on the middle, as well as at the hind margin of the second and third abdominal segments, whereas *Tachina* has only the latter.—[Fourth Rept., p. 40-41.]

This species was simultaneously published by Dr. LeBaron in his 2d Rept. Ins. Ill., p. 123. It is retained in *Exorista* by Osten Sacken.

ANTHOMYIA ZEAE ♀, N. Sp. (Pl. 2, Fig. 24). Length 0.20 [inch, = 5^{mm}]; alar expanse 0.38 [inch, = 9.5^{mm}]. Antennæ black; style microscopically pubescent; front, fulvous, with a distinct, rather narrow, brownish, cinereous margin; face and orbits brownish-white; palpi and proboscis black; ocellar area somewhat heart-shaped; thorax and abdomen pale yellow-brownish cinereous, with minute black points at the insertion of the bristles; thorax with an indistinct middle stripe of brown; legs black, tinted with cinereous; poisers pale ochre-yellow; scales small, the upper valve larger than the lower.—[First Rept., p. 155. Figs. 86, 87, and Pl. II, Fig. 24.]

ANTHOMYIA RADICUM (Linn.) var. **CALOPTENI**.—*Egg*—Oval, smooth, white, 0.04 inch long.

Larva.—Skin unarmed, 0.24 inch [= 6^{mm}] long when extended, of the normal form, the mandibular hooks black, quite conspicuous, and diverging at base. Prothoracic spiracles elongate. Anal spiracles minute, yellowish-brown, with the 8 fleshy surrounding tubercles, small.

Pupa.—Pale-brown, rounded at each end, with the prothoracic spiracles and lips anteriorly, and the anal spiracles and lower tubercles posteriorly, showing as minute points.

Imago.—♀. Average expanse 0.48 inch [= 12^{mm}]. General color ash-gray with a ferruginous hue, especially above, and a more or less intense metallic reflection. Face with white reflections below; eyes smooth, brown, encircled by the ground color, and this behind and on forehead bordered by a brown line; 2 similar lines at back of head from upper corners of eyes and approaching to neck; forehead dusky-brown, becoming bright yellowish-red toward base of antennæ, and the brown forking at right angles around occiput. Trophi and antennæ black, the style simple and somewhat longer than the whole antennæ. Thorax with three dusky longitudinal lines, obsolete behind; legs black, with cinereous hue beneath; wings faintly smoky, with brown-black veins, the discal cross-vein straight and transverse, the outer one bent and more oblique; balancers crumpled, yellowish. Abdomen with faint dusty medio-dorsal spots, broad at base, tapering and obsolescing toward end of each joint.

In the ♂, aside from the larger eyes, stronger bristles, and narrower, less tapering abdomen with its additional joint—all characteristic of the sex—the face is whiter, and the medio-dorsal dark mark of abdomen continuous.

Described from 25 specimens of both sexes, reared from locust-egg-feeding larvae.

Specimens bred from cabbage and radish roots, and others in my cabinet taken from the burrows (made in Osage Orange in Missouri) of *Crabro stirpicola* Pack.; do not differ specifically.—[Ninth Rept., p. 95.]

For further details see First Rept. of the Commission (pp. 285-9), where the species is shown to be the *Anthomyia angustifrons* of Meigen.

ORTHOPTERA.

CALOPTENUS ATLANTIS N. sp.—Length to tip of abdomen 0.70-0.85 inch [= 17.5-21^{mm}]; to tip of closed wings 0.92-1.05 inches [= 23-26^{mm}]. At once distinguished from *femur-rubrum* by the notched character of the anal abdominal joint in the male and by the shorter, less tapering cerci; also by the greater relative length of wings which extend, on an average, nearly one-third their length beyond the tip of the abdomen in the dried specimens: also by the larger and more distinct spot on the wings—in all which characters it much more closely resembles *spretus* than *femur-rubrum*.

From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax and of the pale line from base of wings to hind thigh; also by the anal joint in the ♂, tapering more suddenly and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts—the colors thus more strongly contrasting.

6 ♂'s, ♀'s from New Hampshire. Just as the typical *femur-rubrum* is at once distinguished from the typical *spretus* by the characters indicated; so *Atlantis*, though structurally nearer to *spretus*, is distinguished from it at a glance by its much smaller size and darker, more marbled coloring. The contrast is all the greater in the living specimens, and I have seen no specimens of *spretus* that at all approach it in these respects.

Whether this is the *femur-rubrum* as defined by DeGeer or by Harris, it is almost impossible to decide, though Harris's figure of *femur-rubrum* better represents it than the true *femur-rubrum*, as subsequently defined by Thomas, and as found in Illinois and Missouri.—[Seventh Rept., pp. 169–170.]

For further details and structural differences between it and *C. spretus* see First Report of the Commission.

LIST OF DESCRIPTIONS OF ADOLESCENT STATES.

In making out the following list of descriptions of adolescent states, etc., that appeared in the Reports, the nomenclature there used is retained. Unless otherwise stated the insects, in the particular states indicated, were at the time unknown or undescribed, the descriptions first appearing in the Reports. Those published in connection with the preceding descriptions of new species are omitted here:

HYMENOPTERA.

- Nematus ventricosus*; larva : IX, 21. (Previously described by several writers.)
Pristiphora groesulariæ; larva : IX, 26. (Description quoted from Walsh.)
Emphytus maculatus; larva and pupa : IX, 28-29. (Previously described by me in the *Prairie Farmer*, May 25, 1867.)
Lophyrus abbotii; larva : IX, 32.
Lophyrus lecontei; larva : IX, 33. (This and *abbotii* both partially described by me in the *Prairie Farmer*, November 10, 1866; May 25, 1867; May 2, 1868, and in the *Prairie Farmer Annual*, 1869.)
Tiphia inornata; larva : VI, 126.

COLEOPTERA.

- Harpalus* (probably *herbivagus* Say); larva : IX, 97.
Harpalid; larva : I, 59.
Mysia 15-punctata; larva : IV, 18.
Chilocorus bivulnerus; larva and pupa : I, 16.
Hippodamia convergens; larva and pupa : I, 112. (Previously mentioned in the *Am. Ent.* I, 46, and elsewhere.)
Coccinella picta; larva : V, 101.
Passalus cornutus; larva and pupa : IV, 140-141. (Previously mentioned by Burmeister and by Walsh.); egg : V, 55.
LACHNOSTERNA QUERCINA; egg : V, 55.
Pelidnota punctata; larva and pupa : III, 78-79. (First described by me in *Am. Ent.* II, 295.)
Telephorus bilineatus; larva : IV, 30. (First described by Packard.)
Chauliognathus pensylvanicus; larva : I, 57. (Quoted from the *Am. Ent.* I, 35.)
Chrysobothris femorata; eggs : VII, 73; larva, I, 46. (Previously described by Fitch and others); eggs, larva, and pupa : VII, 73.
Sinoxylon basillare; larva and pupa : IV, 54.
Corynetes rufipes; larva and pupa : VI, 101, 102.
Prionus laticollis; larva : I, 126; larva and pupa : II, 87; egg : V, 56. (*laticollis*.)
Saperda bivittata; pupa : I, 43. (Previously described by Harris.)
Lema trilineata; larva and pupa : I, 99. (From the *Prairie Farmer*; and the *Am. Ent.* I, 26. Previously described by Harris and others.)
Doryphora juncta; larva : I, 106. (First described in the *Am. Ent.* I, 43.)
Doryphora 10-lineata; eggs and larva : I, 105. (From the *Am. Ent.* I, 43. Previously described by me in *Prairie Farmer* Aug. 8, 1863.)

- Colaspis flavida*; larva: III, 84, and IV, 34.
Coscinoptera dominicana; eggs and larva: VI, 123, 130.
Haltica chalybea; larva and pupa: III, 81. (Quoted from *Am. Ent.* II, 327. The larva first described by Packard, *Guide*, p. 507.)
Blepharida rhois; egg, larva and pupa: VI, 121.
Cassida bivittata; larva and pupa: II, 61. (First described by me in the *Prairie Farmer Annual* for 1868, p. 53.)
Cassida aurichalcea; egg: II, 60; larva and pupa: II, 62. (Previously described by Harris.)
Cassida pallida; larva: II, 62.
Cassida guttata; larva and pupa: II, 63.
Cassida nigripes; larva and pupa: II, 63, 64.
Bruchus pisi; egg: III, 47.
Tenebrionid?; larva: VI, 113. (Previously described as the larva of *Eupsalis* by Harris.)
Eupsalis minuta; larva and pupa: VI, 115, 116. (The pupa first described by Harris.)
Conotrachelus cratægi; larva and pupa: III, 39.
Baridius trinotatus; larva and pupa: I, 95. (From the *Am. Ent. I*, 22.)
Anthonomus quadrigibbus; egg: III, 31; larva and pupa: III, 35.

LEPIDOPTERA.

- Papilio philenor*; larva and pupa: II, 117. (Previously described by Smith and Abbot, and by Boisduval and Le Conte; also by Harris in *Ent. Corr.*)
Pieris protodice; larva and pupa: II, 104. (Published simultaneously in the *Am. Ent.* II, 77.)
Pieris rapæ; larva and pupa: II, 108. (Previously described by various authors.)
Danaüs archippus; egg: III, 144.
Limenitis disippus; egg and larva: III, 154. (The mature larva previously described by various authors.)
Apatura lycaon; egg, larva and pupa: VI, 146, 147. (The larva and pupa badly described by Boisd. & Lec.)
Apatura herse; egg, larva and pupa: VI, 148. (The larva and pupa badly described by Boisd. & Lec.)
Paphia glycerium; larva and pupa: II, 127. (First published by me in *Am. Ent.* II, 123); egg and larval changes: V, 146.
Megathymus yuccæ; egg, larva and larval changes: VIII, 174, 181. (First published by me in *Trans. St. Louis Ac.*); IX, 129.
Cherocampa pampinatrix; egg, larva and pupa: II, 71, 72. (Previously described, except egg, by various authors.)
Philampelus achemon; young and full grown larvæ and pupa: II, 74, 75. (Previously described by various authors.)
Philampelus satellitia; eggs, young and full grown larvæ, and pupa: II, 76-78. (Previously described, except egg, by various authors.)
Sphinx 5-maculata; larva pupa: I, 95. (From the *Am. Ent. I*, 23; previously described by several authors.)
Thyreus Abbotii; larva and pupa: II, 78, 79. (Previously described by various authors.)
Deilephila lineata; two forms of larva: III, 141, 142. (Previously described, but not in connection. Quoted from the *Am. Ent.*, II, 258.)
Ægeria acerni; larva and pupa: VI, 110.
Ægeria rubi; larva: VI, 113.
Psychomorpha epimenis; larva and pupa: III, 64, 65; VI, 88. (First described as the possible larva and pupa of *End. unio*, *Am. Ent.* II, 152 and in 1st Rept., p. 84.)
Eudryas grata; eggs, larva and pupa: II, 83; VI, 89, 90. (The larva previously described by Harris and others.)

- Eudryas unio*; *larva* and *pupa*: VI, 92. (First described by Lintner.)
- Alypia ootomaculata*; *larva*: I, 136, (previously mentioned by Fitch); II, 80, published simultaneously in the *Am. Ent.*, II, 151, (previously described in *Harris' Corr.*); VI, 94.
- Procris americana*; *larva* and *pupa*: II, 86. (First described by Harris.)
- Callimorpha fulvicosta*; *larva*: III, 134.
- Spilosoma virginica*; *larva* and *pupa*: III, 69. (Previously described by various authors.)
- Hyphantria textor*; *larva*: III, 132. (First described by Harris.)
- Eopantheria scribonia*; *larva*: IV, 143. (Previously described by other authors.)
- Bombyx mori*; *egg* and *larva*: IV, 86. (Previously well known.)
- Attacus cecropia*; *larval changes*: IV, 106. (Quoted from the *Am. Ent.* II, 100.)
- Attacus cynthia*; *larval changes*: IV, 117. (Previously described by other authors.)
- Attacus promethea*; *larval changes*: IV, 121. (Partially given by other authors previously.)
- Attacus luna*; *larval changes*: IV, 124. (Previously given by Lintner.)
- Attacus polyphemus*; *larval changes*: IV, 126.
- Attacus yama-mai*; *larval changes*: IV, 132. (Previously described by other authors.)
- Attacus pernyi*; *egg*, *larva*, and *cocoon*: IV, 137. (Previously described by other authors.)
- Hemileuca maia*; *egg* and *larval changes*: V, 128, 129. (Previously described by Lintner.)
- Hyperchiria io*; *larval changes*: V, 135. (Previously given by Lintner.)
- Anisota rubicunda*; *eggs* and *larval changes*: V, 138.
- Acronycta oblongata*; *larva* and *pupa*: III, 71. (The larva first figured by Smith & Abb.)
- Acronycta xylinoides*; *larva*: V, 126.
- Amphipyra pyramidoides*; *larva* and *pupa*: III, 73, 74.
- Leucania unipuncta*; *larva* and *pupa*: II, 49; VIII, 33, and *larva*: II, 55 (previously described by various authors); *egg*: VIII, 34; *egg* and *larval changes*: VIII, 184, 185.
- Gortyna nitela*; *larva*: I, 92. (From the *Am. Ent.*, II, 22. Briefly described by Harris, *Treatise*, p. 440; but first identified by me in the *Prairie Farmer*.)
- Agrotis inermis*; *larva* and *pupa*: I, 74.
- Agrotis cochrani*; *larva* and *pupa*: I, 76. (First described by me in the *Prairie Farmer*, June 22, 1867.)
- Agrotis clandestina*; *larva* and *pupa*: I, 79. (Previously mentioned by Harris.)
- Agrotis telifera*; *larva* and *pupa*: I, 81. (Described by me in the *Prairie Farmer*, June 22, 1867; and previously described in Europe, where the species also occurs and is known as *A. ypsilon*.)
- Agrotis subgothica*; *larva*: I, 82.
- Agrotis jaculifera*; *larva* and *pupa*: I, 83.
- Agrotis devastator*; *larva* and *pupa*: I, 84.
- Hadena subjuncta*; *larva* and *pupa*: I, 85.
- Celaena renigera*; *larva* and *pupa*: I, 86.
- Prodenia commelinæ*; *larva*: I, 83; III, 114 (from *Am. Ent.*, II, 363). [See Notes.]
- Anisopteryx vernata*; *larva* and *pupa*: II, 95-97 (previously described by other authors); *eggs*, *larva* and *pupa*: VII, 82 (and 86-87, adapted from Mann); *Paleacrita vernata*, VIII, 13-17 (from the Trans. St. Louis Acad.)
- Anisopteryx pometaria*; *eggs*: II, 94-95 (the two species confounded); *eggs*, *larva* and *pupa*: VII, 84 (and 86-87, adapted from Mann); VIII, 13-17 (from the Trans. St. Louis Acad.)
- Eufitchia ribearia*; *egg*, *larva* and *pupa*: IX, 3, 4. (The larva first described by Fitch.)
- Phacellura nitidalis*; *larva*: II, 67.
- Asopia costalis*; *larva* and *pupa*: VI, 106. (The *larva* mentioned by Harris, but first described by Walsh in the *Prac. Ent.*, and first bred and determined by me, *Prairie Farmer*, April 20, 1867.)

- Phycita nebulo*; *larva and pupa*: IV, 41. (The larva first described by LeBaron.)
Pempelia grossulariæ; *larva and pupa*: I, 141. (Larva previously described by Fitch and by Packard.)
Tortrix rileyana; *larva and pupa*: I, 154.
Anchylopera fragariæ; *larva*: I, 143. (First described in the *Am. Ent.*, I, 90.)
Penthina vitivorana; *larva and pupa*: I, 135. (The larva first described, but not identified, by Rathvon.)
Carpocapsa pomonella; *larva and pupa*: I, 63. (Previously described by various authors.)
Walshia amorphella; *larva and pupa*: II, 133.
Bucculatrix pomifoliella; *larva and pupa*: IV, 51. (Larva previously described by Clemens.)
Ceta compta; *larva and pupa*: I, 152.
Pterophorus periscelidactylus; *larva and pupa*: I, 137; III, 66. (Previously described by Fitch.)
Pterophorus carduidactylus; *larva and pupa*: I, 180.
Pronuba yuccasella; *larva*: V, 155; *pupa*, VI, 131 (from *Trans. St. Louis Acad.*); *egg*, VI, 133 (from *Am. Nat.*).
Orgyia leucostigma; *eggs, larva and pupa*: I, 144-146. (Previously described by others.)
Thyridopteryx ephemeriformis; *eggs, larva and pupa*: I, 148, 149. (Previously described by others.)
Hæmatopis grataria; *eggs, larva and pupa*: I, 179.
Galleria cereana; *larva and pupa*: I, 166. (Previously described by other authors.)

HEMIPTERA.

- Strachia histrionica*; *eggs, larva and pupa*: IV, 37.
Micropus leucopterus; *egg, larval stages and pupa*: VII, 21.
Cicada septemdecim; *egg and young larva*: I, 25. (The eggs previously described by several writers.)
Pæcilopectera pruinosa; *eggs*: V, 122.
Ceresa bubalus; *eggs*: V, 121.
Mytilaspis pinifoliæ; *eggs and larva*: V, 98. (First mentioned by LeBaron.)
Phylloxera rileyi; *larva and pupa*: VI, 64, 86; VII, 120.
Phylloxera vastatrix; *various forms*: VI, 66 (previously described elsewhere and by others); *impregnated egg*: VIII, 159. (Previously described by me in the *Trans. St. Louis Acad.* for Oct. 18, 1875, and independently by Balbiani in the *Comptes rendus de l'Ac. d. Sc. Paris* for Oct. 4, 1875.)
Eriosoma pyri; *larva*: I, 120. (From the *Am. Ent.*, I, 82; previously described by several authors.)

DIPTERA.

- Tabanus atratus*; *larva and pupa*: II, 139, 131. (Previously described, but not specifically identified, by Walsh.)
Erax bastardi; *larva and pupa*: II, 124.
Bombyliid; *larva*: IX, 96.
Pipiza radicum; *larva and pupa*: I, 122. (Quoted from the *Am. Ent.*, I, 84.)
Anthomyia zææ; *larva and puparium*: I, 155.
Meromyza americana; *larva and pupa*: I, 160.
Cestrus ovis; *larva and puparium*: I, 162. (Previously described by other authors.)

ORTHOPTERA.

- Mantis carolina*; *eggs and larva*: I, 170-171. (Previously described by several authors.)
Ceocanthus niveus; *eggs*: V, 120. (Previously described as eggs of *Ceresa bubalus* by Fitch.)

Orchelimum glaberimum; *eggs*: V, 123.

Phaneroptera curvicauda; *eggs*: V, 124, and VI, 165; *larva* and *pupa*: VI, 166.

Microcentrus retinervis; *eggs*: V, 123; VI, 155 (previously described as *eggs* of *Platyphyllum* by Harris); *larva* and *pupa*: VI, 161.

Phylloptera oblongifolia; *eggs*: V, 123. (See *Microcentrus*.)

Platyphyllum concavum; *eggs*: V, 124; VI, 167.

Caloptenus spretus; *eggs* and *egg-mass*: IX, 88, 89; *larva* and *pupa*: VII, 129.

NEUROPTERA.

Corydalus cornutus; *larva* and *pupa*: V, 143, 144 (Previously described by Haldeman);
eggs and *egg-mass*, and *young larva*: IX, 127.

LIST OF DESCRIPTIONS, MOSTLY AMPLIFIED, OF SPECIES NOT NEW.

The following list includes the species, already known, of which a complete redescription of the adult is given in the Reports, either because the original description was in a foreign language, or not easily accessible, or of one sex only, or for other reasons.

HYMENOPTERA.

- Tiphia inornata* Say : VI, 126.
Cryptus extrematis Cress. : IV, 111.
Pezomachus minimus Walsh : II, 52. (From Walsh.)
Ophion purgatus Say : II, 53.
Mesochorus vitreus Walsh : II, 52. (From Walsh.)
Pimpla annulipes Brullé : V, 49.
Macrocentrus delicatus Cress. : V, 50.
Microgaster militaris Walsh : II, 52. (From Walsh.)
Chalcis mariæ Riley : IV, 110. (From the *Am. Ent.*, II, 101-102.)
Isosoma vitis Saunders : II, 93. (From Saunders.)
Antigaster mirabilis Walsh : VI, 163. (From the *Am. Ent.*, II, 169-170.)
Pristiphora grossulariæ Walsh : IX, 26-27. (From the *Prac. Ent.*, I, 123.)
Nematus ventricosus (Klug) : IX, 22. (From the *Prac. Ent.*, I, 120-121, and the *Am. Ent.*, II, 16-17.)
Emphytus maculatus Nort. : IX, 23.
Lophyrus LeContei Fitch : IX, 33.

COLEOPTERA.

- Doryphora 10-lineata* Say, var. : IX, 40.
Sphenophorus zeæ Walsh : III, 59. (From Walsh.)
Scolytus caryæ Riley : V, 107. (Female first described in *Prairie Farmer* Feb. 2, 1867.)
[See Notes.]

LEPIDOPTERA.

- Apatura lycaon* (Fabr.) : VI, 144.
Apatura herse (Fabr.) : VI, 144.
Megathymus yuccæ (Walk.) : VIII, 175-176.
Ægeria polistiformis Harr. : III, 76.
Ægeria acerni Clem. : VI, 110.
Prodenia autumnalis Riley : III, 116-117. (From *Am. Ent.*, II, 365.) [See Notes.]
Leucania unipuncta Haw. : II, 56.
Leucania albilinea Guen. : IX, 56-57.
Acronycta obliuina Sm. & Abb. : III, 71.
Amphipyra pyramidoides Guen. : III, 74.
Celena renigera Steph. : I, 86.
Hadena subjuncta Gr. & Rob. : I, 85.
Noctua clandestina Harr. : I, 79.

- Agrotis inermis* Harr. : I, 74.
Agrotis cochranii Riley : I, 75.
Agrotis telifera Harr. : I, 81.
Agrotis jaculifera Guen. : I, 83.
Anisopteryx pometaria Harr. : VIII, 15-17. (From the Trans. St. Louis Acad. Sc.)
Paleacrita vernata (Peck) : VIII, 15-17. (From the Trans. St. Louis Acad. Sc.)
Asopia costalis (Fab.) : VI, 107.
Pempelia grossulariæ (Pack.) : I, 141.
Walshia amorphella Clem. : II, 133.
Penthina vitivorana Paek. : I, 135.
Euryptychia sa igneana Clem. : II, 134. (From Clemens.)
Tortrix rileyana Grote : I, 154.
Walshia amorphella Clem. : II, 133.
Holcocera glandulella Riley : IV, 145. (From the Can. Ent., IV, 13-19.)
Pronuba yuccasella Riley : V, 150, 151, 155; VI, 131-132. (Both from the Tr./as. St. Louis Acad. Sc.)
Ceta compta Clem. : I, 153.

HEMIPTERA.

- Micropus leucopterus* (Say) : VII, 21, 22.
Mytilaspis pinifoliæ (Fitch) : V, 99.
Eriosoma pyri (Fitch) : I, 120.
Phylloxera vastatrix Planchon : VIII, 159 (From Trans. St. Louis Acad. Sc.); VI, 66-67; VII, 93, 99.
Phylloxera Rileyi Licht. : IV, 66; VI, 64, 88; VII, 118-120.
Phylloxera caryæ-gummosa Riley : VII, 118. (From the Comptes Rendus, Paris Acad. of Sci., Dec. 14, 1874.)
Phylloxera caryæ-ren Riley : VII, 118. (From the Comptes Rendus, Paris Acad. of Sci., Dec. 14, 1874.)
Phylloxera caryæ-fallax Riley : VII, 113. (From the Comptes Rendus, Paris Acad. of Sci., Dec. 14, 1874.)

DIPTERA.

- Erax bastardi* Macq. : II, 124.
Pipiza radicum Walsh & Riley : I, 121-122. (From the Am. Ent. I, 83-84.)
Exorista leucaniæ Walsh : II, 51. (From Walsh.)
Tachina bifasciata (Fabr.) : V, 140.

ORTHOPTERA.

- Caloptenus femur-rubrum* (DeG.) : VII, 126-128.
Caloptenus atlantis Riley : VIII, 117.
Caloptenus spretus (Thos.) : VII, 128-132; VIII, 117.

ACARINA.

- Hoplophora aretata* Riley : VI, 81. (From Trans. St. Louis Acad., III, 216.)
Tyroglyphus phylloxeræ Riley & Planchon : VI, 81. (From Trans. St. Louis Acad., III, 215.)

LIST OF ILLUSTRATIONS.

The illustrations in the Reports were prepared at the author's expense, neither the State nor the Board of Agriculture making any provision therefor. The wood-engraving was done for the most part in St. Louis, by either Wm. Macwitz, Emile Lampe, or Wittemberg & Sorber. Some of it was done by Van Ingen & Snyder, of Philadelphia. A few of the later illustrations are by photo-engraving, and Figs. 50-52 of the 8th Report show the first attempt to combine this process with lithography. In the following list, all drawings were made from nature by the author unless otherwise stated, and when the figure is enlarged the natural size, unless otherwise apparent or stated in this list, will be found indicated in hair-line. The nomenclature of the Reports is retained.

REPORT I.

PLATE I. (Drawn by D. Wiest and lithographed by Bowen & Co., Philadelphia.)

- FIG. 1. Unarmed Rustic (*Agrotis inermis* Harr.), moth.
- FIG. 2. Variegated Cut-worm (*Agrotis inermis* Harr.).
- FIG. 3. Variegated Cut-worm (*Agrotis inermis* Harr.), head, enlarged.
- FIG. 4. Variegated Cut-worm (*Agrotis inermis* Harr.), one joint, enlarged.
- FIG. 5. Climbing Cut-worm Moth (*Agrotis scandens* Riley), wings spread.
- FIG. 6. Climbing Cut-worm Moth (*Agrotis scandens* Riley), wings closed.
- FIG. 7. Climbing Cut-worm (*Agrotis scandens* Riley).
- FIG. 8. Lance Rustic (*Agrotis telifera* Harr.), moth.
- FIG. 9. Greasy Cut-worm (*Agrotis telifera* Harr.).
- FIG. 10. Greasy Cut-worm (*Agrotis telifera* Harr.), head, enlarged.
- FIG. 11. Dart-bearing Rustic (*Agrotis jaculifera* Guen.), moth.
- FIG. 12. *Prodenia commelinæ*, Sin. & Abb., one joint of larva enlarged.
- FIG. 13. Clandestine Owlet Moth (*Noctua clandestina* Harr.).
- FIG. 14. Subjoined Hadenæ (*Hadenæ subjuncta* Gr. & Rob.), moth.
- FIG. 15. Speckled Cut-worm (*Hadenæ subjuncta* Gr. & Rob.), head, enlarged.
- FIG. 16. Speckled Cut-worm (*Hadenæ subjuncta* Gr. & Rob.), one joint, enlarged.
- FIG. 17. Speckled Cut-worm (*Hadenæ subjuncta* Gr. & Rob.), anal joint, enlarged.
- FIG. 18. Eight-spotted Forester (*Alypia octomaculata*, Fabr.).
- FIG. 19. Grape-vine Epimenis (*Psychomorpha epimenis*, Drury), larva. (Mentioned on p. 136, but first named in the 3d Rept., p. 63.)

PLATE II. (Drawn by D. Wiest and lithographed by Bowen & Co., Philadelphia.)

- FIG. 1. Solidago Gall Moth (*Gelechia gallæsolidaginis* Riley), wings expanded.
- FIG. 2. Solidago Gall Moth (*Gelechia gallæsolidaginis* Riley), wings closed.
- FIG. 3. Walnut Tortrix (*Tortrix rileyana* Grote), wings expanded.
- FIG. 4. Walnut Tortrix (*Tortrix rileyana* Grote), wings closed.
- FIG. 5. Solidago Gall Moth (*Gelechia gallæsolidaginis* Riley), larva swollen by the cocoons of the Inflating Chalcis-fly within.
- FIG. 6. Inflating Chalcis-fly, enlarged.
- FIG. 7. *Hemiteles* (?) *cressonii* Riley, enlarged.
- FIG. 8. *Eurytoma bolteri* Riley; male antenna, enlarged.

- FIG. 9. *Eurytonia bolteri* Riley; female, enlarged.
 FIG. 10. Bag of Bag-worm (*Thyridopteryx ephemeraeformis* Steph.), cut to show the cocoons of *Hemiteles* (?) *thyridopterygis*.
 FIG. 11. *Hemiteles* (?) *thyridopterygis* Riley, female.
 FIG. 12. *Hemiteles* (?) *thyridopterygis* Riley, male.
 FIG. 13. Thistle Plume (*Pterophorus carduidactylus* Riley), moth.
 FIG. 14. Thistle Plume (*Pterophorus carduidactylus* Riley), chrysalis.
 FIG. 15. Grape-vine Plume (*Pterophorus periscelidactylus* Fitch), moth.
 FIG. 16. Grape-vine Plume (*Pterophorus periscelidactylus* Fitch), chrysalis.
 FIG. 17. Gooseberry Fruit-worm Moth (*Pempelia grossulariae* Pack.).
 FIG. 18. Chickweed Geometer (*Hematopis grataria*, Fabr.), moth.
 FIG. 19. Chickweed Geometer (*Hematopis grataria*, Fabr.), larva.
 FIG. 20. Chickweed Geometer (*Hematopis grataria*, Fabr.), pupa.
 FIG. 21. Chickweed Geometer (*Hematopis grataria*, Fabr.), eggs.
 FIG. 22. Ailanthus worm (*Eta compta*, Clem.), moth, with spread wings.
 FIG. 23. Ailanthus worm (*Eta compta*, Clem.), moth, with closed wings.
 FIG. 24. Seed-corn Maggot (*Anthomyia zea* Riley), fly, enlarged.
 FIG. 25. Raspberry Geometer (*Aplodes rubivora* Riley), moth.
 FIG. 26. Strawberry Leaf-roller (*Anchylopera fragariae* Walsh & Riley), moth, enlarged.
 FIG. 27. Strawberry Leaf-roller (*Anchylopera fragariae* Walsh & Riley), moth, natural size.
 FIG. 28. American Meromyza (*Meromyza americana* Fitch), fly, enlarged.
 FIG. 29. Grape-berry Moth (*Penthina vitivorana* Pack.), moth, enlarged.
 FIG. 30. Grape-berry Moth (*Penthina vitivorana* Pack.), moth, natural size.

WOOD-CUTS.

- FIG. 1. Harris's Bark-louse (*Aspidiotus Harrisii* Walsh).
 FIG. 2. Oyster-shell Bark-louse (*Aspidiotus conchiformis*, Gmélín).
 FIG. 3. Oyster-shell Bark-louse (*Aspidiotus conchiformis*, Gmélín). 1, egg (natural size scarcely .01.) 2, larva, as it appears when running over the twigs (natural size .01.) 3, its appearance after becoming fixed. 4, appearance of scale after the second plate is formed. 5, form of louse (ventral view) soon after losing its members. 6, form of louse (ventral view) when full grown and just about to deposit. 7, fully formed scale, containing louse, as it appears from the under side when raised. 8, highly magnified antenna of larva, showing joints.
 FIG. 4. Twice-stabbed Ladybird (*Chilocorus bivulnerus* Muls.). [From the *Practica Entomologist*.]
 FIG. 5. Twice-stabbed Ladybird (*Chilocorus bivulnerus* Muls.), larva.
 FIG. 6. Seventeen-year Cicada (*Cicada septemdecim* Linn.). A, ♂ of typical form; c, d, genital hooks; g, singing apparatus. B, ♂ of the small form (*cassinii*); e, f, genital hooks.
 FIG. 7. Seventeen-year Cicada (*Cicada septemdecim*, Linn.). a, pupa; b, cast pupa shell; c, imago; d, punctured twig; e, two eggs.
 FIG. 8. Seventeen-year Cicada (*Cicada septemdecim* Linn.), galleries made by pupa; a, front view, c, orifice; b, section, c, pupa awaiting time of change, d, pupa ready to transform.
 FIG. 9. Twig punctured by the Seventeen-year Cicada (*Cicada septemdecim* Linn.).
 FIG. 10. Twig healed after the puncture of the Seventeen-year Cicada (*Cicada septemdecim* Linn.).
 FIG. 11. Thirteen-year Cicada (*Cicada tredecim* Linn.), newly hatched larva.
 FIG. 12. *Stizus grandis* Say, ♀.
 FIG. 13. Seventeen-year Cicada (*Cicada septemdecim* Linn.), side view of ♀ to show beak, a, and ovipositor, b.

- FIG. 14. Round-headed Apple-tree Borer (*Saperda bivittata* Say). *a*, larva; *b*, pupa; *c*, imago.
- FIG. 15. Flat-headed Apple-tree Borer (*Chrysobothris femorata*, Fabr.), larva.
- FIG. 16. Flat-headed Apple-tree Borer (*Chrysobothris femorata*, Fabr.), imago.
- FIG. 17. Peach-tree Borer (*Egeria exilis* Say); 1, ♀; 2, ♂.
- FIG. 18. Plum Curculio (*Conotrachelus nenuphar*, Herbst); *a*, larva; *b*, pupa; *c*, imago; *d*, plum and curculio, natural size, the plum bearing one of the punctures.
- FIG. 19. Pennsylvania Soldier-beetle (*Chauliognathus pensylvanicus*, DeGeer). *a*, larva, natural size; *b*, head and first segment enlarged; *c*, under lip (*labium*); *d*, upper lip (*labrum*); *e*, leg; *f*, left lower jaw (*maxilla*); *g*, antenna; *h*, left upper jaw (*mandible*).
- FIG. 20. Lacewing (*Chrysopa* sp.); *a*, eggs; *b*, larva; *c*, cocoon, the upper figure showing the lid; *d*, imago. [*a*, *b*, *d* after Westwood.]
- FIG. 21. Subangular Ground-beetle (*Aspidoglossa subangulata* Chaud.).
- FIG. 22. Carabid larva. *A*, natural size; *B*, under side of head, enlarged; *c*, mandible; *e*, antenna; *f*, labium and labial palpi; *g*, maxilla and its palpi; *h*, joint 12 beneath; *i*, joint 11 beneath; *j*, joints 4-10 each beneath—enlarged.
- FIG. 23. Pennsylvania Ground-beetle (*Harpalus pensylvanicus*, DeGeer).
- FIG. 24. Codling-moth (*Carpocapsa pomonella*, Linn.) *a*, apple showing the work of the larva; *b*, point of entrance of the larva; *d*, pupa; *e*, larva; *f*, *g*, moth; *h*, head of larva; *i*, cocoon.
- FIG. 25. Pupa of Cut-worm in earthen cell. [After Curtis.]
- FIG. 26. Dark-sided Cut-worm (*Agrotis Cochranii* Riley). *a*, larva; *b*, moth.
- FIG. 27. W-marked Cut-worm (*Noctua clandestina* Harr.).
- FIG. 28. Lance Rustic (*Agrotis telifera* Harr.), moth.
- FIG. 29. Gothic Dart (*Agrotis subgothica*, Haw.), moth.
- FIG. 30. Glassy Cut-worm (*Agrotis devastator*, Brace). Lower figure represents the side of one of the middle segments.
- FIG. 31. Figure 8 Minor (*Calena renigera* Steph.). *a*, moth; *b*, larva.
- FIG. 32. *Microgaster militaris* Walsh. [After Walsh.]
- FIG. 33. Spined Soldier-bug (*Arma spinosa* Dallas). *a*, beak magnified; *b*, bug with right wing spread.
- FIG. 34. Fiery Ground-beetle (*Calosoma calidum*, Fabr.); *a*, larva; *b*, beetle.
- FIG. 35. Potato-stalk Borer (*Gortyna nitela* Guen.) 1, moth; 2, larva.
- FIG. 36. Potato-stalk Borer (*Gortyna nitela* Guen.) larva.
- FIG. 37. Potato-stalk Weevil (*Baridius trinotatus*, Say); *a*, larva; *b*, pupa; *c*, beetle, (all enlarged).
- FIG. 38. Potato- or Tomato-worm (*Sphinx 5-maculata* Haw.). *A*, larva; *B*, pupa; *C*, moth. [After Harris.]
- FIG. 39. Striped Blister-beetle (*Lytta vittata* Fabr.). [From *Practical Entomologist*.]
- FIG. 40. *a*, Ash-gray Blister-beetle (*Lytta cinerea* Fabr.), *d*, antennæ; *b*, Black-rat Blister-beetle (*Lytta murina* Lec.), *c*, antennæ.
- FIG. 41. Margined Blister-beetle (*Lytta marginata* Fabr.). [From *Practical Entomologist*.]
- FIG. 42. Three-lined Potato-beetle (*Lema trilineata*, Oliv.); *a*, larva; *b*, tip of its body; *c*, pupa; *d*, eggs. [From *Practical Entomologist*.]
- FIG. 43. Three-lined Potato-beetle (*Lema trilineata*, Oliv.). [From *Practical Entomologist*.]
- FIG. 44. Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.). [From *Practical Entomologist*.]
- FIG. 45. Cucumber Flea-beetle (*Haltica cucumeris* Harr.). [From *Practical Entomologist*.]
- FIG. 46. Colorado Potato-beetle (*Doryphora 10-lineata*, Say); *a*, eggs; *b*, larva, in different stages; *c*, pupa; *d*, imago or beetle; *e*, wing-cover, enlarged; *f*, leg, enlarged.

- FIG. 47. Bogus Colorado Potato-beetle (*Doryphora juncta*, Germar); *a*, eggs; *b*, larva; *c*, beetle; *d*, wing-cover, enlarged; *e*, leg, enlarged.
- FIG. 48. Colorado Potato-beetle Parasite (*Lydella doryphoræ* Riley).
- FIG. 49. Spotted Ladybird (*Hippodamia maculata*, DeGeer). [From *Practical Entomologist*.]
- FIG. 50. Nine-spotted Ladybird (*Coccinella 9-notata* Herbst). [From *Practical Entomologist*.]
- FIG. 51. Thirteen-spotted Ladybird (*Hippodamia 13-punctata*, Linn.).
- FIG. 52. Convergent Ladybird (*Hippodamia convergens* Guer.).
- FIG. 53. Ladybird larva. [After Westwood.]
- FIG. 54. Spined Soldier-bug (*Arma spinosa* Dallas); *a*, beak enlarged; *b*, bug; *c*, enlarged beak of an allied plant-feeder (*Euschistus punctipes*, Say).
- FIG. 55. Common Squash-bug (*Coreus tristis*, DeGeer); *b*, enlarged beak.
- FIG. 56. Bordered Soldier-bug (*Stiretrus fimbriatus*, Say).
- FIG. 57. Many-banded Robber (*Harpactor cinctus*, Fabr.); *b*, enlarged beak.
- FIG. 58. Rapacious Soldier-bug (*Reduvius raptatorius* Say).
- FIG. 59. Virginian Tiger-beetle (*Tetracha virginica* Hope).
- FIG. 60. Fiery Ground-beetle (*Calosoma calidum*, Fabr.).
- FIG. 61. Elongate Ground-beetle (*Pasimachus elongatus* Lec.).
- FIG. 62. Murky Ground-beetle (*Harpalus caliginosus* Say).
- FIG. 63. Pincers for crushing Potato-beetles.
- FIG. 64. Apple-root Plant-louse (*Eriosoma pyri*, Fitch); *a*, affected root; *b*, larva; *c*, winged louse; *d*, leg; *e*, proboscis; *f*, antenna of winged louse; *g*, antenna of larva (all greatly enlarged).
- FIG. 65. Vagabond Plant-louse (*Pemphigus vagabundus*, Walsh).
- FIG. 66. Root-louse Syrphus-fly (*Pipiza radicum* Riley); *a*, larva; *b*, puparium from which the fly has emerged; *c*, fly.
- FIG. 67. Gigantic Grape-root Borer (*Prionus laticollis*, Drury).
- FIG. 68. Gigantic Grape-root Borer (*Prionus laticollis*, Drury); head and thoracic joints.
- FIG. 69. Cylindrical Orthosoma (*Orthosoma cylindricum*, Fabr.).
- FIG. 70. Grape Curculio (*Cealiodes inæqualis*, Say); *a*, infested grape; *b*, larva.
- FIG. 71. Grape Curculio (*Cealiodes inæqualis*, Say). [After Walsh.]
- FIG. 72. Grape Curculio (*Cealiodes inæqualis*, Say); front leg. [After Walsh.]
- FIG. 73. Grape-seed Maggot (*Isosoma vitis* Saunders).
- FIG. 74. Grape-cane Gall-curculio (*Baridius Sesostris* Lec.).
- FIG. 75. Grape-vine Fidia (*Fidia viticida* Walsh). [From *Practical Entomologist*.]
- FIG. 76. Grape Fruit-worm (*Penthina vitivorana* Pack. = *Lolexia botrana* Schiff.); *a*, pupa; *b*, cocoon.
- FIG. 77. Snowy Tree-cricket (*Ecanthus nireus* Harr.), ♂. [From *Practical Entomologist*.]
- FIG. 78. Snowy Tree-cricket (*Ecanthus nireus* Harr.), ♀. [From *Practical Entomologist*.]
- FIG. 79. Gooseberry Fruit-worm (*Pempelia grossulariæ* Pack.); *a*, cocoon; *b*, moth. [After Packard.]
- FIG. 80. Strawberry Leaf-roller (*Anchylopera fragariæ* Walsh & Riley; *a*, larva; *b*, anterior part enlarged; *d*, anal segment; *c*, moth.
- FIG. 81. White-marked Tussock Moth (*Orgyia leucostigma*, Sm. & Abb.); *a*, ♀ on cocoon; *b*, larva; *c*, female pupa; *d*, male pupa.
- FIG. 82. White-marked Tussock Moth (*Orgyia leucostigma*, Sm. & Abb.); female caterpillar.
- FIG. 83. White-marked Tussock Moth (*Orgyia leucostigma*, Sm. & Abb.), male.
- FIG. 84. Bag-worm (*Thyridopteryx ephemeraformis* Haw.); *a*, larva; *b*, male chrysalis; *c*, female moth; *d*, male moth; *e*, female chrysalis in bag, sectional view; *f*, caterpillar and bag; *g*, very young caterpillars in their bags.
- FIG. 85. Walnut Tortrix (*Tortrix Rileyana* Grote); *a*, larva; *b*, side view of one segment.

- FIG. 86. Seed-corn Maggot (*Anthomyia zeæ* Riley); *a*, enlarged; *b*, puparium.
- FIG. 87. Seed-corn Maggot (*Anthomyia zeæ* Riley); kernels of corn containing the maggot.
- FIG. 88. White Grub or May-beetle (*Lachnosterna quercina*, Knoch); 1, pupa; 2, the grub; 3, 4, the beetle.
- FIG. 89. White Grub attacked by fungus.
- FIG. 90. American Meromyza (*Meromyza americana* Fitch); *a*, infested stalk; *b*, maggot; *c*, pupa.
- FIG. 91. Sheep Head Maggot (*Estrus ovis* Linn.); 1 and 2, the Gad-fly; 3, the puparium; 4, larva, dorsal view; 5, larva, ventral view; 6, younger larva; *a*, head; *b*, corneous appendages at anus; *c*, spiracles.
- FIG. 92. Bee-moth (*Galleria cereana* Fabr.); *a*, larva; *b*, cocoon; *c*, pupa; *d*, *e*, moth.
- FIG. 93. Nebraska Bee-killer (*Trupanea apivora* Fitch = *Promachus Fitchii* O. S.).
- FIG. 94. Camel-cricket (*Mantis carolina*, Linn.); *a*, female; *b*, male.
- FIG. 95. Camel-cricket (*Mantis carolina*, Linn.), egg-masses.
- FIG. 96. Solidago Gall of *Gelechia gallæsolidaginis* Riley; *a*, section of gall; *b*, whole gall; *c*, orifice through which the moth escapes; *d*, excrement of the larva; *e*, larva.
- FIG. 97. *Eurytoma Bolteri* Riley; antennæ of ♂ and ♀.
- FIG. 98. Thistle Plume-moth (*Pterophorus carduidactylus* Riley = *Pt. cardui* Zellern), anterior and posterior joints of the larva.

REPORT II.

- FIG. 1. Chinch-bug (*Micropus leucopterus*, Say).
- FIG. 2. Chinch-bug (*Micropus leucopterus*, Say), short-winged form.
- FIG. 3. Spotted Ladybird (*Hippodamia maculata*, DeGeer). [From *Practical Entomologist*.]
- FIG. 4. Trim Ladybird (*Coccinella munda* Say).
- FIG. 5. Lacewing (*Chrysopa* sp.). [After Westwood.]
- FIG. 6. Insidious Flower-bug (*Anthocoris insidiosus*, Say).
- FIG. 7. Spined Soldier-bug (*Arma spinosa* Dallas).
- FIG. 8. Ash-gray Leaf-bug (*Piesma cinerea*, Say).
- FIG. 9. Flea-like Negro-bug (*Corimelena pulicaria*, Germar).
- FIG. 10. Bordered Soldier-bug (*Stiretrus fimbriatus*, Say).
- FIG. 11. Tent-caterpillar of the Forest (*Clisiocampa sylvatica* Harr.).
- FIG. 12. Cotton-worm (*Anomis zylina*, Say); *a*, egg; *b*, worm, one-third grown; *d*, top view; *c*, side view of full-grown worm; *e*, cocoon; *f*, chrysalis. [Adapted from Glover.]
- FIG. 13. Cotton-worm Moth (*Anomis zylina*, Say); *a*, with wings expanded; *b*, wings closed.
- FIG. 14. Army-worm (*Leucania unipuncta* Haw.).
- FIG. 15. Army-worm (*Leucania unipuncta* Haw.), chrysalis.
- FIG. 16. Army-worm Moth (*Leucania unipuncta* Haw.).
- FIG. 17. Red-tailed Tachina-fly (*Exorista leucaniæ* Kirk.).
- FIG. 18. Yellow-tailed Tachina-fly (*Exorista flavicauda* Riley).
- FIG. 19. Glassy Mesochorus (*Mesochorus vitreus* Walsh). [After Walsh.]
- FIG. 20. *Pezomachus minimus* Walsh. [After Walsh.]
- FIG. 21. *Pezomachus minimus* Walsh; bunch of cocoons. [After Walsh.]
- FIG. 22. *Chalcis albifrons* Walsh. [After Walsh.]
- FIG. 23. *Microgaster militaris* Walsh. [After Walsh.]
- FIG. 24. *Glyphe viridascens* Walsh. [After Walsh.]
- FIG. 25. *Ophion purgatus* Say.
- FIG. 26. Clubbed Tortoise-beetle (*Deloyala clavata*, Oliv.).
- FIG. 27. Two-striped Sweet-potato Beetle (*Cassida bivittata* Say); 2, larva; 3, pupa; 4, beetle.

- FIG. 28. *Chelymorpha cribraria*, Fabr.; pupa (enlarged). [After Packard.]
- FIG. 29. *Chelymorpha cribraria*, Fabr. (enlarged). [After Packard.]
- FIG. 30. *Physonota quinquepunctata* Walsh & Riley; a, larva; b, beetle.
- FIG. 31. Golden Tortoise-beetle (*Cassida aurichalcea*, Fabr.), egg.
- FIG. 32. Two-striped Sweet-potato Beetle (*Cassida divittata* Say), larvæ.
- FIG. 33. Golden Tortoise-beetle (*Cassida aurichalcea*, Fabr.), larva; a, natural size; b, enlarged and with the dung taken from the fork.
- FIG. 34. Golden Tortoise-beetle (*Cassida aurichalcea*, Fabr.); a, pupa; b, beetle.
- FIG. 35. Mottled Tortoise-beetle (*Cassida guttata*, Oliv.); a, larva; b, pupa.
- FIG. 36. Mottled Tortoise-beetle (*Cassida guttata*, Oliv.).
- FIG. 37. Black-legged Tortoise-beetle (*Cassida nigripes* Oliv.); a, larva; b, larva cleaned and enlarged; c, pupa (enlarged).
- FIG. 38. Black-legged Tortoise-beetle (*Cassida nigripes* Oliv.).
- FIG. 39. Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.). [From *Practical Entomologist*.]
- FIG. 40. Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.), larva; a, dorsal view; b, side view.
- FIG. 41. Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.) pupa; 1, ventral; 2, dorsal view.
- FIG. 42. Twelve-spotted Diabrotica (*Diabrotica 12-punctata*, Oliv.). [From *Practical Entomologist*.]
- FIG. 43. Pickle-worm (*Phacellura nitidalis* Cram.); a, natural size; b, head and first joints, enlarged; c, side view of a joint, enlarged; d, cervical shield, enlarged; e, side of first joint, enlarged; f, 2d joint from above, enlarged; g, anal joint, enlarged; h, cocoon; i, moth, male.
- FIG. 44. Hog-caterpillar of the Vine (*Cherocampa pampinatrix*, Sm. & Abb.).
- FIG. 45. Hog-caterpillar of the Vine (*Cherocampa pampinatrix*, Sm. & Abb.), chrysalis.
- FIG. 46. Hog-caterpillar of the Vine (*Cherocampa pampinatrix*, Sm. & Abb.), moth.
- FIG. 47. Microgaster cocoons or Hog-caterpillar of the Vine (*Chær. pampinatrix*, Sm. & Abb.) [After Harris.]
- FIG. 48. *Microgaster* = *Apanteles*. [After Harris.]
- FIG. 49. Achemon Sphinx (*Philampelus achemon*, Drury), caterpillar.
- FIG. 50. Achemon Sphinx (*Philampelus achemon*, Drury), chrysalis.
- FIG. 51. Achemon Sphinx (*Philampelus achemon*, Drury), moth.
- FIG. 52. Satellite Sphinx (*Philampelus satellitia*, Linn.); a, full-grown larva; b, its position at rest; c, young larva.
- FIG. 53. Satellite Sphinx (*Philampelus satellitia*, Linn.), moth.
- FIG. 54. Abbot Sphinx (*Thyreus Abbotii* Swainson); larva and moth.
- FIG. 55. Eight-spotted Forrester (*Alypia octomaculata*, Fabr.); a, caterpillar; b, side view of one joint; c, moth.
- FIG. 56. Beautiful Wood-nymph (*Eudryas grata*, Fabr.).
- FIG. 57. ? Pearl Wood-nymph (*Eudryas unio*, Hüb.); a, larva; b, side view of one segment enlarged; c, hump on 11th joint, enlarged. (See 3d Rep., Fig. 25.)
- FIG. 58. American Procris (*Procris americana* Boisd.); a, larva; b, chrysalis; c, cocoon; d, e, moth.
- FIG. 59. American Procris (*Procris americana* Boisd.), larvæ.
- FIG. 60. Gigantic Grape-root Borer (*Prionus laticollis*, Drury).
- FIG. 61. Broad-necked Prionus (*Prionus laticollis*, Drury), female.
- FIG. 62. Gigantic Grape-root Borer (*Prionus laticollis*, Drury), pupa.
- FIG. 63. Tile-horned Prionus (*Prionus imbricornis*, Linn.), male.
- FIG. 64. Grape-seed Maggot (*Isosoma vitis* Saunders).
- FIG. 65. Joint-worm Fly (*Isosoma hordei*, Harr.); a, female; b, male; c, ♀ antenna; d, ♂ antenna; e, ♀ abdomen; f, ♂ abdomen.

- FIG. 66. Canker-worm; *a*, eggs of Fall Canker-worm (*Anisopteryx pometaria* Harr.); *b*, five eggs of same, enlarged; *c*, larva of Spring Canker-worm (*Paleacrita vernata*, Peck), *d*, cocoon, *e*, chrysalis, *f*, male moth, *g*, female moth—all probably of *vernata*. (See 6th Rept., p. 29). [*a*, *b*, *c*, *d*, *e*, after Harris; *f*, *g*, after Packard.]
- FIG. 67. Spring Canker-worm (*Paleacrita vernata*, Peck), head enlarged.
- FIG. 68. Mite (*Nothrus oviivorus* Pack.), enlarged. [After Packard.]
- FIG. 69. Rummaging Ground-beetle (*Calosoma scrutator*, Fabr.).
- FIG. 70. Fiery Ground-beetle (*Calosoma calidum*, Fabr.).
- FIG. 71. Fraternal Potter-wasp (*Eumenes fraterna* Say); *b*, clay nest; *c*, same cut open.
- FIG. 72. Southern Cabbage-butterfly (*Pieris protodice* Boisd.); *a*, caterpillar; *b*, chrysalis.
- FIG. 73. Southern Cabbage-butterfly (*Pieris protodice* Boisd.), female.
- FIG. 74. Southern Cabbage-butterfly (*Pieris protodice* Boisd.), male.
- FIG. 75. Potherb Butterfly (*Pieris oleracea* Boisd.). [After Harris.]
- FIG. 76. Potherb Butterfly (*Pieris oleracea* Boisd.), chrysalis. [After Harris.]
- FIG. 77. Imported Cabbage-butterfly (*Pieris rapæ* Schrank.); *a*, larva; *b*, chrysalis. [After Curtis.]
- FIG. 78. Imported Cabbage-butterfly (*Pieris rapæ* Schrank.), female.
- FIG. 79. Imported Cabbage-butterfly (*Pieris rapæ* Schrank.), male.
- FIG. 80. Butterfly Net: 5, socket; 6, ring.
- FIG. 81. Cabbage Plusia (*Plusia brassicæ* Riley); *a*, caterpillar; *b*, chrysalis in cocoon; *c*, moth, male.
- FIG. 82. Zebra-caterpillar (*Mamestra picta* Harr.); *a*, caterpillar; *b*, moth.
- FIG. 83. Tarnished Plant-bug (*Capsus oblineatus* Say).
- FIG. 84. Philenor Swallow-tail (*Papilio philenor* Drury), caterpillar.
- FIG. Philenor Swallow-tail (*Papilio philenor* Drury); *a*, chrysalis, back view; *b*, lateral outline.
- FIG. 86. Philenor Swallow-tail (*Papilio philenor* Drury).
- FIG. 87. Cottonwood Dagger (*Acronycta populi* Riley); caterpillar.
- FIG. 88. Cottonwood Dagger (*Acronycta populi* Riley).
- FIG. 89. Missouri Bee-killer (*Asilus missouriensis* Riley).
- FIG. 90. Wing of *Promachus* (*a*), *Asilus* (*b*), *Erax* (*c*).
- FIG. 91. Silky Asilus (*Asilus sericeus* Say). [After Harris.]
- FIG. 92. *Erax bastardi* Macq., larva.
- FIG. 93. *Erax bastardi* Macq.; *a*, fly; *b*, pupa.
- FIG. 94. Goat-weed Butterfly (*Paphia glycerium* Doubl.); *a*, caterpillar; *b*, chrysalis.
- FIG. 95. Goat-weed Butterfly (*Paphia glycerium* Doubl.), male.
- FIG. 96. Goat-weed Butterfly (*Paphia glycerium* Doubl.), female.
- FIG. 97. Black Breeze-fly (*Tabanus atratus* Fabr.); *a*, larva; *b*, pupa shell; *c*, fly.
- FIG. 98. False-indigo Gall-moth (*Walshia amorphella* Clem.); *a*, moth; *b*, caterpillar; *c*, gall; *d*, section of gall, showing larva in burrow.
- FIG. 99. Misnamed Gall-moth (*Euryptychia saligneana* Clem.); *a*, moth; *b*, gall with protruding pupa-shell.

REPORT III.

- FIG. 1. Plum Curculio (*Conotrachelus nenuphar*, Herbst); *a*, larva; *b*, pupa; *c*, curculio, enlarged; *d*, punctured plum with curculio resting on it, natural size.
- FIG. 2. The Hull Curculio-catcher.
- FIG. 3. The Hull Curculio-catcher; viewed from beneath; *a*, slide for closing central hole, *d*; *b* *b*, handles; *c* *c*, wheels; *e*, *f*, position of bag.
- FIG. 4. The Hull Curculio-catcher; viewed from above.
- FIG. 5. Strips of sheeting for closing up the tree-way in Hull's Curculio-catcher.
- FIG. 6. The Hooten Curculio-catcher.

- FIG. 7. *Sigalphus Curculio*-parasite (*Sigalphus curculionis* Fitch); *a*, male; *b*, female; *c*, antenna.
- FIG. 8. *Sigalphus Curculio*-parasite (*Sigalphus curculionis* Fitch); *a*, larva; *b*, cocoon; *c*, pupa.
- FIG. 9. Porizon Curculio-parasite (*Porizon conotrachelii* Riley); *a*, ♀; *b*, ♂; *c*, antenna.
- FIG. 10. Apple Curculio (*Anthonomus quadrigibbus* Say); *a*, natural size; *b*, side view; *c*, back view.
- FIG. 11. Apple Curculio (*Anthonomus quadrigibbus* Say); *a*, pupa; *b*, larva.
- FIG. 12. Quince Curculio (*Conotrachelus crataegi* Walsh.); *a*, side; *b*, back.
- FIG. 13. Plum Gouger (*Anthonomus prunicida* Walsh.).
- FIG. 14. Strawberry Crown-borer (*Analois fragariae* Riley); *a*, larva; *b*, side view of beetle; *c*, dorsal view.
- FIG. 15. Pea-weevil (*Bruchus pisi* Linn.); *a*, beetle; *b*, injured pea.
- FIG. 16. Pea-weevil (*Bruchus pisi* Linn.), egg enlarged.
- FIG. 17. Pea-weevil (*Bruchus pisi* Linn.); *b*, beetle, side view; *c*, larva; *d*, pupa, dorsal view; *g*, pea, infested. [After Curtis.]
- FIG. 18. Grain Bruchus (*Bruchus granarius* Linn.). [After Curtis.]
- FIG. 19. American Bean-weevil (*Bruchus fabae* Riley); *a*, beetle; *b*, bean, infested.
- FIG. 20. New York Weevil (*Ithycerus novaboracensis*, Forster); *a*, excavation made by female to deposit eggs; *b*, larva; *c*, beetle.
- FIG. 21. Imbricated Snout-beetle (*Epicærus imbricatus*, Say).
- FIG. 22. Corn Sphenophorus (*Sphenophorus zeæ* Walsh); *a*, back view; *b*, outline side view; *c*, enlarged punctures of elytra.
- FIG. 23. Cocklebur Sphenophorus (*Sphenophorus pulchellus* Schæn.); *a*, back view; *b*, outline side view.
- FIG. 24. Grape Leaf-folder (*Desmia maculalis* Westw.); 1, caterpillar in folded leaf; 2, enlarged view of head and anterior joints; 3, chrysalis; 4, male moth; 5, female moth.
- FIG. 25. Grape-vine Epimenis (*Psychomorpha epimenis*, Drury); *a*, larva; *b*, side view of one segment, enlarged; *c*, hump on 11th joint, enlarged.
- FIG. 26. Grape-vine Epimenis (*Psychomorpha epimenis*, Drury), moth, male.
- FIG. 27. Grape-vine Plume (*Pterophorus periscelidactylus* Fitch); *a*, caterpillars in their retreat; *b*, chrysalis; *c*, one of the dorsal processes of chrysalis; *d*, moth; one joint of larva enlarged, side view.
- FIG. 28. Yellow-bear Caterpillar (*Spilosoma virginica*, Fabr.); *a*, caterpillar; *b*, chrysalis; *c*, moth.
- FIG. 29. Smeared Dagger (*Acronycta obliterata*, Sm. & Abb.); *a*, caterpillar; *b*, cocoon; *c*, moth.
- FIG. 30. *Aleiodes* Rileyi Cress.; hardened skin of caterpillar of the Smeared Dagger (*Acronycta obliterata*, Sm. & Abb.) from which the *Aleiodes* has emerged.
- FIG. 31. Pyramidal Grape-vine Worm (*Amphipyra pyramidoides* Guen.), moth.
- FIG. 32. Pyramidal Grape-vine Worm (*Amphipyra pyramidoides* Guen.).
- FIG. 33. Grape-root Borer (*Ageria polistiformis* Harr.); *a*, male; *b*, female.
- FIG. 34. Spotted Pelidnota (*Pelidnota punctata*, Linn.); *a*, larva; *b*, pupa; *c*, beetle; *d*, anal joint of larva; *e*, antenna of larva; *f*, leg of larva.
- FIG. 35. Grape-vine Flea-beetle (*Haltica chalybea* Illiger); *a*, larvæ on leaf; *b*, larva, enlarged; *c*, earthen cell containing pupa; *d*, beetle. [*d* after Harris.]
- FIG. 36. Grape-vine Flea-beetle (*Haltica chalybea* Illiger). [From *Practical Entomologist*.]
- FIG. 37. Grape-vine Colaspis (*Colaspis flavida* Say); 1, enlarged; 2, natural size.
- FIG. 38. Grape-vine Colaspis (*Colaspis flavida* Say); *a*, enlarged side view of larva; *b*, terminal joints seen from beneath.
- FIG. 39. Galls of the Grape Phylloxera (*Phylloxera vitifoliae*, Fitch = *vastatrix* Pl.).

- FIG. 40. Grape Phylloxera (*Phylloxera vitifolia*, Fitch = *Ph. vastatrix* Pl.); *a*, the winged female; *b*, her foot or tarsus—after Signoret; *c*, egg; *d*, newly-hatched gall-inhabiting type; *e*, same, dorsal view; *f*, section of gall; *g*, tubercled root-inhabiting form; *h*, mother gall-louse at height of her fertility; *i*, same, dorsal view; *j*, *k*, differently veined wings of the Oak Phylloxera of Europe.
- FIG. 41. Great Lebia (*Lebia grandis* Hentz.).
- FIG. 42. Boll-worm (*Heliothis armigera* Hübn.) on tomato.
- FIG. 43. Boll-worm (*Heliothis armigera* Hübn.); *a*, egg, side view; *b*, egg, top view; *c*, caterpillar; *d*, chrysalis in earthen cocoon; *e*, moth, wings expanded; *f*, moth, wings closed. [*a*, *b*, *c*, *d* after Glover.]
- FIG. 44. Army-worm (*Leucania unipuncta* Haw.).
- FIG. 45. Fall Army-worm (*Prodenia autumnalis* Riley = *Laphygma frugiperda*, Sm. & Abb.); *a*, natural size; *b*, head magnified; *c*, one segment enlarged, from above; *d*, same, from side.
- FIG. 46. Fall Army-worm (*Prodenia autumnalis* Riley = *Laphygma frugiperda*, Sm. & Abb.); *a*, *b*, *c*, three varieties.
- FIG. 47. Army-worm Moth (*Leucania unipuncta* Harr.).
- FIG. 48. Spiderwort Owlet-moth (*Prodenia commelinae*, Abb.); *a*, caterpillar; *b*, *c*, dark and light varieties of the moth. [See Notes, etc., p. 56.]
- FIG. 49. Unarmed Rustic (*Agrotis inermis* Harr. = *A. saucia* Hübn.); *a*, egg, enlarged; *b*, batch of eggs, natural size.
- FIG. 50. Apple-tree Tent-caterpillar (*Clisiocampa americana* Harr.); *a*, *b*, caterpillars; *c*, eggs; *d*, cocoon.
- FIG. 51. Apple-tree Tent-caterpillar (*Clisiocampa americana* Harr.) moth.
- FIG. 52. Tent-caterpillar of the Forest (*Clisiocampa sylvatica* Harr.); *a*, eggs; *b*, female moth; *c*, egg enlarged, top view; *d*, enlarged eggs, side view.
- FIG. 53. Tent-caterpillar of the Forest (*Clisiocampa sylvatica* Harr.).
- FIG. 54. Rummaging Ground-beetle (*Calosoma scrutator*, Fabr.).
- FIG. 55. Fall Web-worm (*Hyphantria textor* Harr.); *a*, caterpillar; *b*, chrysalis; *c*, moth.
- FIG. 56. Blue-spangled Peach-worm (*Callimorpha fulvicosta* Clem.); *a*, caterpillar; *b*, moth; *c*, one segment enlarged, side view; *d*, same, top view.
- FIG. 57. Ash-gray Pinion (*Xylina cinerea* Riley); *a*, worm in fruit; *b*, moth.
- FIG. 58. Glassy-winged Soldier-bug (*Campyloneura vitripennis*, Say).
- FIG. 59. Glassy-winged Soldier-bug (*Campyloneura vitripennis*, Say), pupa.
- FIG. 60. White-lined Morning Sphinx (*Deilephila lineata*, Fabr.), moth.
- FIG. 61. White-lined Morning Sphinx (*Deilephila lineata*, Fabr.), caterpillar, light form.
- FIG. 62. White-lined Morning Sphinx (*Deilephila lineata*, Fabr.); caterpillar, dark form.
- FIG. 63. Archippus Butterfly (*Danais archippus*, Fabr.).
- FIG. 64. Archippus Butterfly (*Danais archippus*, Fabr.); *a*, egg, greatly enlarged; *c*, natural size; *e*, *f*, lateral and dorsal views of a segment of the larva in its first stage, enlarged; *b*, larva in act of casting its skin, to show how the flexible horns are folded (*d*).
- FIG. 65. Archippus Butterfly (*Danais archippus*, Fabr.), caterpillar.
- FIG. 66. Archippus Butterfly (*Danais archippus*, Fabr.); *a*, *b*, *c*, successive stages in changing from caterpillar to chrysalis.
- FIG. 67. Archippus Butterfly (*Danais archippus*, Fabr.), chrysalis.
- FIG. 68. Disippus Butterfly (*Limenitis disippus*, Godt.), showing upper surface of left wing, and under surface on the right. [After Harris.]
- FIG. 69. Disippus Butterfly (*Limenitis disippus*, Fabr.); *a*, egg greatly enlarged; *c*, natural size; *d*, one cell of the egg-shell, greatly magnified; *b*, one segment of the larva, in its first stage.
- FIG. 70. Disippus Butterfly (*Limenitis disippus*, Fabr.); *a*, caterpillar; *b*, chrysalis; *c*, hibernaculum; *d*, leaf cut for hibernaculum.

- FIG. 71. Disippus Butterfly (*Limenitis disippus*, Fabr.); a leaf eaten by the caterpillar.
- FIG. 72. Disippus Egg-parasite (*Trichogramma? minuta* Riley); a, fly with wings folded; b, front wing; c, hind wing; d, leg; e, antenna—all enlarged.
- FIG. 73. *Microgaster militaris* Walsh. [After Walsh.]

REPORT IV.

- FIG. 1. Perforated tin box for sifting paris green.
- FIG. 2. Creighton's "Improved Patent Insect Destroyer."
- FIG. 3. Grand-Daddy-Long-Legs (*Phalangium dorsatum* Say).
- FIG. 4. Fifteen-spotted Ladybird (*Mysia 15-punctata*, Oliv.); a, larva; b, pupa; c, first joint of larva, enlarged; d, e, f, g, different varieties of the beetle.
- FIG. 5. Icy Ladybird (*Hippodamia glacialis* Fabr.).
- FIG. 6. Ring-banded Soldier-bug (*Perillus circumcinctus* Stål); b, antenna; c, beak (enlarged).
- FIG. 7. Dotted-legged Plant-bug (*Enschistus punctipes*, Say); c, beak (enlarged).
- FIG. 8. Spined Soldier bug (*Arma spinosa* Dallas); a, beak (enlarged).
- FIG. 9. Spined Soldier-bug (*Arma spinosa* Dallas); a, pupa; b, larva; c, egg (all enlarged).
- FIG. 10. Rove-beetle (*Philonthus apicalis*, Say).
- FIG. 11. Rove-beetle larva (*Goërius olens*). [After Westwood.]
- FIG. 12. Rove-beetle (*Quedius molochinus*, Grav.), pupa.
- FIG. 13. Wier's Apple-worm Trap.
- FIG. 14. Pennsylvania Soldier-beetle (*Chauliognathus pensylvanicus* DeG.); a, larva; b, head and prothorax, enlarged; c, labium; d, labrum; e, leg; f, maxilla; g, antenna; h, mandible.
- FIG. 15. Two-lined Soldier-beetle (*Telephorus bilineatus*, Say); a, larva; b, anterior joints enlarged; c, beetle.
- FIG. 16. Grape-vine Colaspis (*Colaspis flarida* Say); one joint of larva, viewed from beneath and enlarged; b, head of larva, from beneath; c, same, from above, enlarged.
- FIG. 17. Harlequin Cabbage-bug (*Strachia histrionica* Hahn); a, larva; b, pupa; c, eggs; d, eggs enlarged, side view; e, same, top view; g, bug; h, same, with wings expanded.
- FIG. 18. Rascal Leaf-crumpler (*Phycita nebulo* Walsh); a, case, containing caterpillar; b, cases in winter; c, head and thoracic joints of larva, enlarged; d, moth.
- FIG. 19. Larval cases of the Rascal Leaf-crumpler (*Phycita nebulo* Walsh) in winter.
- FIG. 20. Walnut Case-bearer (*Acrobasis juglandis* LeBaron); a, case, between two leaflets; b, case; c, wings of *nebulo* for comparison; d, wings of moth; e, wings of a variety of same from the crab-apple.
- FIG. 21. Apple-leaf Skeletonizer (*Pempelia Hammondi* Riley); a, larva; b, middle joint, enlarged; c, anterior joints, enlarged; d, moth.
- FIG. 22. Green Apple-leaf-tyer (*Tortrix cinderella* Riley); a, caterpillar; b, chrysalis; c, moth; d, pupal case.
- FIG. 23. Apple-leaf Bucculatrix (*Bucculatrix pomifoliella* Clem.); a, cocoons on twig; b, cocoon, enlarged; c, moth.
- FIG. 24. Apple-twig Borer (*Bostrichus bicaudatus*, Say). [After Walsh.]
- FIG. 25. Apple-twig Borer (*Bostrichus bicaudatus*, Say); twigs bored by this insect.
- FIG. 26. Red-shouldered Sinoxylon (*Sinoxylon basillare*, Say); a, larva; b, pupa; c, beetle.
- FIG. 27. Red-shouldered Sinoxylon (*Sinoxylon basillare*, Say); a, head and thoracic joints of larva greatly enlarged; b, labrum and mandibles; c, anterior leg; d, intermediate leg; e, posterior leg.

- FIG. 28. Grape Phylloxera (*Phylloxera vitifolia*, Fitch = *Ph. vastatrix* Pl.); *a*, shows a healthy root; *b*, one on which the lice are working, representing the knots and swellings caused by their punctures; *c*, a root that has been deserted by them, and where the rootlets have commenced to decay; *d, d, d*, shows how the lice are found on the larger roots; *e*, female pupa, dorsal view; *f*, same, ventral view; *g*, winged female, dorsal view; *h*, same, ventral view; *i*, magnified antenna of winged insect; *j*, side view of the wingless female, laying eggs on roots; *k*, shows how the punctures of the lice cause the larger roots to rot.
- FIG. 29. Mulberry Silkworm (*Bombyx mori* Linn.), larva.
- FIG. 30. Mulberry Silkworm (*Bombyx mori* Linn.), cocoon.
- FIG. 31. Mulberry Silkworm (*Bombyx mori* Linn.), moth.
- FIG. 32. Mulberry Silkworm (*Bombyx mori* Linn.), cocoons; *a*, White French Annual; *b*, Yellow French Annual; *c*, Green Japanese Annual; *d*, White Japanese Annual; *e*, White Chinese Annual.
- FIG. 33. Cecropia Silkworm Moth (*Attacus Cecropia* Linn.).
- FIG. 34. Cecropia Silkworm (*Attacus Cecropia* Linn.), cocoon.
- FIG. 35. Cecropia Silkworm (*Attacus Cecropia* Linn.), chrysalis.
- FIG. 36. Cecropia Silkworm (*Attacus Cecropia* Linn.).
- FIG. 37. *Ophion macrurum*, Linn. [After Packard.]
- FIG. 38. *Ophion macrurum*, Linn., larva.
- FIG. 39. Mary Chalcis-fly (*Chalcis maria* Riley).
- FIG. 40. Cecropia Cryptus (*Cryptus samia* Pack.), cocoons within the larger Cecropia cocoon.
- FIG. 41. Cecropia Cryptus (*Cryptus samia* Pack.); *a*, female; *b*, female abdomen of *C. nuncius*; *c*, male abdomen; *d*, highly magnified piece of wing.
- FIG. 42. Ailanthus Silkworm (*Attacus cyntia*, Hübn.); 1, caterpillar; 2, moth; 3, cocoon; 4, chrysalis; 5, eggs.
- FIG. 43. Promethia Silkworm (*Attacus promethea* Drury); *a*, third stage; *b*, head in fourth stage, enlarged; *c*, lateral view of a joint in fourth stage, enlarged; *d*, full-grown caterpillar.
- FIG. 44. Promethia Silkworm (*Attacus promethea* Drury), cocoon.
- FIG. 45. Promethia Moth (*Attacus promethea* Drury), male. [After Harris.]
- FIG. 46. Promethia Moth (*Attacus promethea* Drury), female. [After Harris.]
- FIG. 47. Luna Moth (*Attacus Luna* Linn.). [After Harris.]
- FIG. 48. Luna Silkworm (*Attacus Luna* Linn.).
- FIG. 49. Luna Silkworm (*Attacus Luna* Linn.), cocoon. [After Harris.]
- FIG. 50. Polyphemus Moth (*Attacus Polyphemus* Linn.), male.
- FIG. 51. Polyphemus Moth (*Attacus Polyphemus* Linn.), female. [After Harris.]
- FIG. 52. Polyphemus Silkworm (*Attacus Polyphemus* Linn.). [After Trouvelot.]
- FIG. 53. Polyphemus Silkworm (*Attacus Polyphemus* Linn.), cocoon. [After Trouvelot.]
- FIG. 54. Polyphemus Silkworm (*Attacus Polyphemus* Linn.), chrysalis. [After Trouvelot.]
- FIG. 55. Yama-mai Moth (*Attacus yama-mai*, Guér.-Mén.), male.
- FIG. 56. Yama-mai Silkworm (*Attacus yama-mai*, Guér.-Mén.); egg, natural size and enlarged; young caterpillar on leaf; full grown caterpillar at rest on twig.
- FIG. 57. Yama-mai Silkworm (*Attacus yama-mai*, Guér.-Mén.), at rest on leafy twig, at *a*. [After Adams.]
- FIG. 58. Yama-mai Silkworm (*Attacus yama-mai*, Guér.-Mén.), cocoon.
- FIG. 59. Cage for receiving the deposition of the eggs of Yama-mai Moth. [After Adams.]
- FIG. 60. Pernyi Moth (*Attacus Pernyi*, Guér.-Mén.).
- FIG. 61. Pernyi Silkworm (*Attacus Pernyi*, Guér.-Mén.); egg, natural size and enlarged cocoon.

- FIG. 62. Horned Passalus (*Passalus cornutus* Fabr.); *a*, larva; *b*, pupa; *c*, beetle; *d*, under side of three thoracic joints of larva, showing legs; *e*, metathoracic leg of larva.
- FIG. 63. Great Leopard-moth (*Epantheria scribonia*, Stoll.), *a*, caterpillar; *b*, one hair, enlarged.
- FIG. 64. Great Leopard-moth (*Epantheria scribonia*, Stoll.); *a*, female; *b*, male.
- FIG. 65. Isabella Tiger-moth (*Arctia isabella*, Smith); *a*, caterpillar; *b*, chrysalis; *c*, moth.
- FIG. 66. Acorn-moth (*Holococera glandulella* Riley); *a*, caterpillar in acorn; *b*, perforated acorn; *c*, head and thoracic joints of caterpillar, enlarged; *d*, *e*, lateral and dorsal views of one segment of larva; *f*, moth; *g*, base of antenna of male.

REPORT V.

- FIG. 1. Pyramid, showing the nature of the mouth, the relative rank of the Orders and the affinities of the Sub-orders of Insects.
- FIG. 2. Bald-faced Hornet (*Vespa maculata* Linn.). [After Sanborn.]
- FIG. 3. Goldsmith-beetle (*Cotalpa lanigera*, Linn.).
- FIG. 4. *Deiopsia bella*, Drury.
- FIG. 5. Dotted-legged Plant-bug (*Euschistus punctipes*, Say).
- FIG. 6. Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.); *a*, side view; *b*, view from above.
- FIG. 7. Missouri Bee-killer (*Anilus missouriensis* Riley).
- FIG. 8. Differential Locust (*Caloptenus differentialis* Walk.).
- FIG. 9. Dragon-fly (*Libellula trimaculata*, DeGeer.) [After Sanborn.]
- FIG. 10. Hull's Curculio-catcher.
- FIG. 11. Butterfly net; *b*, hinge in the ring; *c*, ring folded; *d*, nut sunk and soldered into brass tube at end of handle; *e*, screw; *f*, tip of handle, showing attachment of the ring.
- FIG. 12. Butterfly net; *a*, ring; *b*, socket; *c*, cork plug.
- FIG. 13. Butterfly net, head for attaching the ring to the rod.
- FIG. 14. Poison-bottle for killing insects; *a*, wadding to keep the cyanide grains in place.
- FIG. 15. Chloroform in stoppered bottle with brush.
- FIG. 16. Chloroform in bottle with tube passing through the cork.
- FIG. 17. Method of pinning insects; *a*, beetle; *b*, bug.
- FIG. 18. Method of carding small insects.
- FIG. 19. Method of "setting" Lepidoptera on a spreading board.
- FIG. 20. Setting-needle.
- FIG. 21. Sections of framework of glass-covered volume to display showy insects; *a*, ends; *b*, front; *c*, back.
- FIG. 22. Forceps for pinning insects.
- FIG. 23. Forceps for pinning insects.
- FIG. 24. Forceps for pinning insects.
- FIG. 25. Breeding-cage; *a*, bottom board; *b*, four-sided frame, with glass sides and door, fitting over a zinc pan (*f*) attached to the bottom board; *c*, cover fitting to the frame and having a wire gauze top; *d*, zinc tube attached in centre of the pan, to contain a bottle for the reception of the food plant; *e*, sand in the pan; *gg*, cross pieces for supporting the cage and to prevent warping.
- FIG. 26. Ring-legged Pimpla (*Pimpla annulipes* Br.), female; to the right a figure of the ovipositor to show the two inner rods; to the left the abdomen of the male.
- FIG. 27. Delicate Longsting (*Macrocentrus delicatus* Cress.); to the right the abdomen of the male.
- FIG. 28. Rust-red Social Wasp (*Polistes rubiginosus* St. Farg.); *b*, nest, the natural position being with the mouths of the cells down.

- FIG. 29. Apple-tree Tent-caterpillar (*Clisiocampa americana* Harr.), eggs.
- FIG. 30. Grape Phylloxera (*Phylloxera vastatrix* Plan.); *a*, *b*, peculiar pedunculated galls; *c*, gall just forming; *d*, same from beneath.
- FIG. 31. Oyster-shell Bark-louse (*Mytilaspis pomicorticis* Riley); *a*, male louse from beneath; *b*, same from above and with wings expanded; *c*, male scale; *d*, leg of male; *e*, portion of wing very highly magnified; *f*, one joint of male antennæ (all highly magnified).
- FIG. 32. Oyster-shell Bark-louse (*Mytilaspis pomicorticis* Riley); anal joint of louse, with a more highly magnified segment of edge at *b*, and of a single pore at *c*; *d*, female louse; *e*, a section of its proboscis more highly magnified; *g h f*, female scale, *h*, first scale, *g*, second scale, *f*, third scale.
- FIG. 33. Mite (*Dermaleichus*?).
- FIG. 34. *Aphelinus mytilaspidis* LeBaron.
- FIG. 35. Pine-leaf Scale-insect (*Mytilaspis pinifoliae*, Fitch.); *a*, scales on leaves of white pine; *b*, male scale; *c*, female scale from white pine; *d*, female scale from broader leaved pine (*b*, *c* and *d*, enlarged).
- FIG. 36. Pine-leaf Scale-insect (*Mytilaspis pinifoliae*, Fitch); male, highly magnified.
- FIG. 37. Painted Ladybird (*Coccinella picta* Randall); *a*, larva; *b*, beetle; *c*, beetle, enlarged.
- FIG. 38. Hickory Bark-borer (*Scolytus caryæ* Riley); 1, view of its galleries on the inside of the bark, showing the beetle in the central gallery and the larvæ at the ends of the side galleries; 2, burrows made by larger larvæ; 3, beetle, magnified and natural size; 4, larva, magnified and natural size; 5, pupa, magnified; 6, sculpture of elytra, magnified.
- FIG. 39. Rose Chafer (*Macrodactylus subspinosus*, Fabr.), with the enlarged anterior tibia at the left.
- FIG. 40. Chinch-bug (*Micropus leucopterus*, Say).
- FIG. 41. False Chinch-bug (*Nysius destructor* Riley); *a*, potato leaf showing some effects of its punctures; *b*, pupa; *c*, mature bug.
- FIG. 42. Grape-vine Apple-gall (*Vitis-pomum* Walsh & Riley); *a*, exterior; *b*, section.
- FIG. 43. Gall-gnat (*Cecidomyia salicis-strobiloides* Walsh), *a*, female; *b*, male antennæ.
- FIG. 44. Grape-vine Filbert-gall (*Vitis-coryloides* W. & R.); *a*, anterior joints of larva, showing breast-bone; *b*, cluster of galls; *c*, section of single gall.
- FIG. 45. Grape-vine Tomato-gall (*Vitis-tomatos* Riley = *Lasioptera vitis* O. S., gall); *a*, section of a single swelling.
- FIG. 46. Grape-vine Trumpet-gall (*Vitis-viticola* Riley = *Cecidomyia viticola* O. S.)
- FIG. 47. Jumping Tree-cricket (*Orocharis saltator* Uhler) eggs in grape twig; *a*, eggs; *b*, punctures; *c*, egg, enlarged.
- FIG. 48. Jumping Tree-cricket (*Orocharis saltator* Uhler); *a*, female; *b*, male.
- FIG. 49. Snowy Tree-cricket (*Ecanthus niveus* Harr.) eggs; *a*, punctures in twig; *b*, section of twig showing the eggs within; *c*, egg, enlarged; *d*, granulations at rounded end of egg, more highly magnified.
- FIG. 50. Buffalo Tree-hopper (*Ceresa bubalus* Fabr.) eggs in slits in the bark of a tree; *a*, one slit enlarged; *b*, natural size.
- FIG. 51. Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.); *a*, side; *b*, dorsal view.
- FIG. 52. Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.); *a*, larva; *b*, pupa; *c*, ovipositor of the female, all enlarged.
- FIG. 53. Egg-punctures of Tree-hopper (?) on apple twigs; *a*, natural size; *b*, enlarged.
- FIG. 54. Frosted Lightning-hopper (*Paciloptera pruinosa*, Say) eggs; *a*, enlarged; *b*, in position within twig, enlarged; *c*, natural size.
- FIG. 55. Frosted Lightning-hopper (*Paciloptera pruinosa*, Say).
- FIG. 56. Egg-punctures of (?) *Orchelimum glaberrimum* (Burm.).
- FIG. 57. Eggs of the Angular-winged Katydid (*Microcentrus retinervis*, Burm.); *a*, front; *b*, side view, just before hatching.

- FIG. 58. Eggs of the Angular-winged Katydid (*Microcentrus retinervia*, Burm.); *a*, front; *b*, side view, soon after laid.
- FIG. 59. Eggs of the Broad-winged Katydid (*Platyphyllum concavum* Harr.); *a*, side; *b*, front view, enlarged; *c*, *d*, natural size.
- FIG. 60. Buck Moth (*Hemileuca maia*, Drury).
- FIG. 61. Buck Moth (*Hemileuca maia*, Drury) eggs.
- FIG. 62. Buck Moth (*Hemileuca maia*, Drury); *a*, full-grown larva; *b*, pupa; *c*, ordinary form of spine of larva in the first stage; *d*, branched spine on thoracic joints of same; *e*, form of spines in second stage of larva; *f*, *g*, spines of full-grown larva.
- FIG. 63. Io Moth (*Hyperchiria Io*, Fabr.), male.
- FIG. 64. Io Moth (*Hyperchiria Io*, Fabr.), female.
- FIG. 65. Io Moth (*Hyperchiria Io*, Fabr.), caterpillar.
- FIG. 66. Io Moth (*Hyperchiria Io*, Fabr.), spines in 1st (*c*), 2d (*b*), and 5th (*a*) stages of caterpillar.
- FIG. 67. Green-striped Maple-worm (*Dryocampa rubicunda*, Fabr.); *a*, caterpillar; *b*, chrysalis; *c*, female moth.
- FIG. 68. *Belvoisia bifasciata*, Fabr.
- FIG. 69. Hellgrammite Fly (*Corydalis cornutus*, Linn.); *a*, larva; *b*, pupa; *c*, male fly; *d*, outline of head and prothorax of female.
- FIG. 70. Hellgrammite Fly (*Corydalis cornutus*, Linn.); supposed eggs.
- FIG. 71. Hellgrammite Fly (*Corydalis cornutus*, Linn.), pupa.
- FIG. 72. Goat-weed Butterfly (*Paphia glycerium* Doubl.); *a*, leaf eaten by the larva (natural size); *b*, head of larva in the first stage; *c*, larva in third stage; *d*, head in second stage; *e*, head in fourth stage — all enlarged.
- FIG. 73. Painted-wing Digger-wasp (*Ammophila pictipennis* Walsh).
- FIG. 74. Yucca-moth (*Pronuba yuccasella* Riley); *a*, head with pollen mass (1), (2) the maxillary tentacle, (3) the maxillae, (4) maxillary palpi, (5) antenna; *b*, maxillary palpi with tentacle; *c*, single spine from maxillary tentacle; *d*, maxillary palpus of male; *e*, wing scale; *f*, anterior leg; *g*, labial palpus; *h*, venation of anterior wing; *i*, venation of posterior wing, male; *j*, last joint of the abdomen of the female with the ovipositor exerted — all enlarged.
- FIG. 75. Yucca-moth (*Pronuba yuccasella* Riley); *a*, larva; *b*, moth with wings folded; *c*, female moth with wings expanded, (all natural size); *d*, side view of one joint of larva; *e*, head of larva from below; *f*, same from above; *g*, leg of larva; *h*, maxilla; *i*, mandible; *j*, labial palpi and spinneret; *k*, antenna — all enlarged.

REPORT VI.

- FIG. 1. Potato-beetle Catcher. Made of five barrel hoops and four (BB. EE) barrel staves, covered with cotton cloth.
- FIG. 2. Grape Phylloxera (*Phylloxera vastatrix* Planchon), galls on the leaf, seen from beneath.
- FIG. 3. Grape Phylloxera (*Phylloxera vastatrix* Plan.); *a*, *b*, pedunculated galls; *c*, gall just forming; *d*, same from beneath.
- FIG. 4. Grape Phylloxera (*Phylloxera vastatrix* Plan.)—Type Gallicola; *a*, *b*, newly-hatched larva, ventral and dorsal view; *c*, egg; *d*, section of gall; *e*, swelling of tendril; *f*, *g*, *h*, mother gall-louse—lateral, dorsal and ventral views; *i*, her antenna; *j*, her two-jointed tarsus.
- FIG. 5. Grape Phylloxera (*Phylloxera vastatrix* Plan.)—Type Radicola; *a*, roots of Clinton vine, showing relation of swellings to leaf galls, and power of resisting decomposition; *b*, larva as it appears when hibernating; *c*, *d*, antenna and leg of same; *e*, *f*, *g*, forms of more mature lice; *h*, granulations of skin; *i*, tubercle; *j*, transverse folds at border of joints; *k*, simple eyes.

- FIG. 6. Grape Phylloxera (*Phylloxera vastatrix* Plan.)—Type Radicicola; *a*, shows a healthy root; *b*, one on which the lice are working, representing the knots and punctures caused by their punctures; *c*, a root that has been deserted by them, and where the rootlets have commenced to decay; *d*, *d*, *d*, show how the lice are found on the larger roots; *e*, female pupa, dorsal view; *h*, same, ventral view; *i*, magnified antenna of winged insect; *j*, side view of the wingless female, laying eggs on roots; *k*, shows how the punctures of the lice cause the larger roots to rot.
- FIG. 7. Grape Phylloxera (*Phylloxera vastatrix* Plan.). Pterogostic characters; *a*, *b*, different venation of front wing; *c*, hind wing; *d*, *e*, *f*, showing development of wings.
- FIG. 8. Grape Phylloxera (*Phylloxera vastatrix* Plan.)—Type Radicicola; *a*, *b*, pupa and imago of a problematical individual or supposed male; *c*, *d*, its antenna and leg; *e*, vesicles found in abdomen.
- FIG. 9. Thrips, enlarged, wings at right more highly enlarged.
- FIG. 10. Lace-wing fly (*Chrysopa* sp.); *a*, eggs; *b*, larva; *c*, cocoon, the upper figure with the lid open after the fly has escaped; *d*, fly, the wings omitted on the left. [*a*, *b*, *d*, after Westwood.]
- FIG. 11. Ladybird (*Hippodamia convergens* Gué.); larva, pupa and beetle.
- FIG. 12. Syrphus larva; *b*, one joint enlarged.
- FIG. 13. Syrphus-fly (*Helophilus latifrons* Loew).
- FIG. 14. Insidious Flower-bug (*Anthrenus insidiosus*, Say).
- FIG. 15. Root-louse Syrphus-fly (*Pipiza radicum* W. & R.); *a*, larva; *b*, pupa; *c*, fly.
- FIG. 16. Phylloxera Mite (*Tyroglyphus phylloxera* Planchon & Riley); *a*, dorsal; *b*, ventral view of female; *c*, mouth parts; *d*, *f*, *g*, *h*, forms of tarsal appendages; *e*, ventral tubercles of male.
- FIG. 17. *Hoplophora arcata* Riley; *a*, *b*, *c*, *d*, *e*, different attitudes assumed by it; *f*, strongly magnified leg.
- FIG. 18. American Oak Phylloxera (*Phylloxera Rileyi* Lichtn.); *a*, pupa; *b*, winged females; *c*, antenna greatly enlarged; *d*, portion of infested leaf, under side.
- FIG. 19. American Oak Phylloxera (*Phylloxera Rileyi* Lichtn.); *a*, *b*, dorsal and ventral views of larva as seen hibernating; *c*, *d*, highly magnified leg and antenna of same.
- FIG. 20. Grape-vine Epimenis (*Psychomorpha epimenis*, Drury); *a*, larva; *b*, one joint, enlarged, side view; *c*, hump on joint 11.
- FIG. 21. Grape-vine Epimenis (*Psychomorpha epimenis*, Drury), male moth.
- FIG. 22. Beautiful Wood-nymph (*Eudryas grata*, Fabr.); *a*, full grown larva; *b*, one joint, enlarged, side view; *c*, cervical shield from behind; *d*, anal hump from behind; *e*, *f*, top and side views of egg.
- FIG. 23. Beautiful Wood-nymph (*Eudryas grata*, Fabr.), female moth.
- FIG. 24. Pearl Wood-nymph (*Eudryas unio*, Hübn.), male moth.
- FIG. 25. Eight-spotted Forester (*Alypia octomaculata*, Fabr.); *a*, larva; *b*, one joint, enlarged, side view; *c*, female moth.
- FIG. 26. Red-legged Ham-beetle (*Corynetes rufipes*, Fabr.); *a*, larva; *b*, pupa; *c*, cocoon; *d*, beetle, enlarged; *e*, same, natural size; *f*, leg of larva; *g*, mandible, *h*, labium, *i*, maxilla, *j*, antenna, of larva—all enlarged.
- FIG. 27. Larder-beetle (*Dermestes lardarius* Linn.); *a*, larva; *b*, one of its barbed hairs; *c*, beetle.
- FIG. 28. Clover-hay Worm (*Asopia costalis*, Fabr.); 1, 2, larva; 3, cocoon; 4, chrysalis; 5, 6, moth with wings expanded, and closed; 7, worm covered with silken web.
- FIG. 29. Legged Maple Borer (*Egeria aceris*, Clem.); *a*, *a*, larva, dorsal and lateral views; *b*, *b*, *b*, cocoons exposed by detachment of bark; *c*, moth; *d*, chrysalis skin as it is often left remaining in the hole of exit.

- FIG. 30. Raspberry-root Borer (*Egeria rubi* Riley); *a*, male moth; *b*, female moth.
- FIG. 31. Northern Brentthian (*Euscelis minuta*, Drury); *a*, larva; *b*, pupa; *c*, female beetle; *d*, head of male do.; *f*, leg of larva; *g*, head of larva, from in front; *h*, labium; *i*, labrum; *j*, mandible; *k*, maxilla; *l*, head from beneath, all of larva and enlarged; *m*, end of body of pupa, dorsal view.
- FIG. 32. Larva of Tenebrionid (?); *b*, front view of head; *c*, mandible; *f*, antenna; *g*, maxilla; *h*, labium; *d*, *e*, concave end of the body, full and side views.
- FIG. 33. Sumach Flea-beetle (*Blepharida rhois*, Forst.); *a*, egg; *b*, *b*, egg-masses, covered with excrement; *c*, *c*, *c*, *c*, larva; *d*, cocoon; *e*, pupa; *f*, beetle; *g*, antenna of larva; *h*, maxilla do.; *i*, mandible do.; *j*, labium do.; *k*, labrum do.; *l*, leg do.
- FIG. 34. *Tiphia inornata* Say; *a*, perfect wasp; *b*, head of larva, enlarged; *c*, larva, ventral view; *d*, cocoon cut open.
- Report VI, p. 122. Jiggers (*Leptus irritans* Riley, to the right; *L. americanus* Riley, to the left).
- FIG. 35. White-grub Fungus (*Torrubia ravenelii*, Berk.).
- FIG. 36. Dominican Case-bearer (*Coscinoptera dominicana*, Fabr.); *a*, larva extracted from case; *b*, do. with case; *c*, beetle, showing punctures; *d*, same, natural size; *e*, egg, enlarged; *i*, eggs, natural size; *g*, head of male beetle, enlarged; *h*, mandible of same, more enlarged; *j*, leg of larva, with the claw joint more enlarged; *f*, under side of larva; *k*, its mandible; *l*, maxilla, all enlarged.
- FIG. 37. *Chlamys plicata*, Oliv.; *a*, larva extracted from case, the figure at the right showing the larva in the case. [After Packard.]
- FIG. 38. Yucca-moth (*Pronuba yuccasella* Riley); *m*, female chrysalis; *l*, male chrysalis, the apical joints more highly enlarged and viewed from the side in lower figure.
- FIG. 39. Eyed Emperor (*Apatura lycaon*, Fabr.); *a*, eggs; *b*, larva; *c*, *d*, chrysalis, dorsal and lateral views; *e*, imago, male, the dotted line showing form of female—all natural size.
- FIG. 40. Eyed Emperor (*Apatura lycaon*, Fabr.); *f*, egg, magnified; *g*, larva, lateral view; *h*, imago, under side—natural size; *i*, *j*, *k*, *l*, *m*, the five different larval heads; *n*, *o*, dorsal and lateral views of one joint of larva—enlarged.
- FIG. 41. Tawny Emperor (*Apatura herse*, Fabr.); *a*, eggs; *b*, larva; *c*, chrysalis; *d*, imago, male, the dotted line showing form of female—all natural size.
- FIG. 42. Tawny Emperor (*Apatura herse*, Fabr.); *g*, larva, half grown, dorsal view; *h*, imago, male, under side—natural size; *i*, *j*, *k*, *l*, *m*, the five different heads of larva; *n*, *o*, dorsal and lateral views of one joint of larva; *p*, egg—enlarged; *g*, larvæ as when hibernating—natural size.
- FIG. 43. Eggs of the Angular-winged Katydid (*Microcentrus retinervis*, Burm.); *a*, front; *b*, side view, just before hatching.
- FIG. 44. Eggs of Angular-winged Katydid (*Microcentrus retinervis*, Burm.); *a*, front; *b*, side view, soon after laid.
- FIG. 45. Angular-winged Katydid (*Microcentrus retinervis*, Burm.); male wings closed.
- FIG. 46. Angular-winged Katydid (*Microcentrus retinervis*, Burm.); *a*, ovipositor of female, nat. size; *b*, tip of same, enlarged.
- FIG. 47. Angular-winged Katydid (*Microcentrus retinervis*, Burm.); female ovipositing.
- FIG. 48. Back-rolling Wonder (*Antigaster mirabilis* Walsh); *a*, female, wings expanded; *b*, same, side view, partly rolled up; *c*, same nearly rolled up; *d*, antenna of same.
- FIG. 49. Back-rolling Wonder (*Antigaster mirabilis* Walsh); *a*, eggs of *Microcentrus* from which it has issued; *b*, female pupa, ventral view; *c*, male fly; *d*, his antenna.
- FIG. 50. Narrow-winged Katydid (*Phaneroptera curvicauda*, DeGeer); female. [After Harris.]

- FIG. 51. Narrow-winged Katydid (*Phaneroptera curvicauda* DeGeer); *a*, ovipositor of female, nat. size; *d*, end of same, enlarged; *c*, anal appendage of male, side view; *b*, same, back view.
- FIG. 52. Broad-winged Katydid (*Platyphyllum concavum* Harr.); male (after Harris). [Adapted from Harris.]
- FIG. 53. Broad-winged Katydid (*Platyphyllum concavum* Harr.); *a*, ovipositor of female, nat. size; *b*, end of same, enlarged.
- FIG. 54. Eggs of Broad-winged Katydid (*Platyphyllum concavum* Harr.); *a*, side; *b*, front view—enlarged; *c*, *d*—natural size.
- FIG. 55. Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer), outline of female [adapted from Harris]; *b*, end of ovipositor, enlarged.

REPORT VII.

- FIG. 1. Gray's Improved Sprinkler, for the use of Paris Green water. [From inventor.]
- FIG. 2. Chinch-bug (*Micropus leucopterus*, Say).
- FIG. 3. Chinch-bug (*Micropus leucopterus*, Say); *a*, *b*, eggs; *c*, newly hatched larva; *d*, its tarsus; *e*, larva after first molt; *f*, same after second molt; *g*, pupa, the natural sizes indicated at sides; *h*, enlarged leg of perfect bug; *j*, tarsus of same still more enlarged; *i*, proboscis or beak, enlarged.
- FIG. 4. Chinch-bug (*Micropus leucopterus*, Say), short-winged form.
- FIG. 5. Spotted Ladybird (*Hippodamia maculata*, DeGeer). [From *Practical Entomologist*.]
- FIG. 6. Trim Ladybird (*Coccinella munda* Say).
- FIG. 7. Insidious Flower-bug (*Anthocoris insidiosus*, Say).
- FIG. 8. Many-banded Robber (*Harpactor cinctus*, Fabr.); *a*, bug; *b*, its beak, enlarged.
- FIG. 9. False Chinch-bug (*Nysius destructor* Riley); *b*, pupa; *c*, mature bug.
- FIG. 10. Ash-gray Leaf-bug (*Piesma cinerea* Say).
- FIG. 11. Flea-like Negro-bug (*Corimelana pulicaria*, Germar); natural size and enlarged.
- FIG. 12. Flat-headed Apple-tree Borer (*Chrysobothris femorata*, Fabr.); *a*, larva, dorsal view; *b*, pupa; *c*, swollen thoracic joints of larva from beneath; *d*, beetle.
- FIG. 13. Cherished Bracon (*Bracon charus* Riley).
- FIG. 14. Spring Canker-worm (*Anisopteryx vernata*, Peck); *a*, full grown larva; *b*, egg, enlarged, the natural size shown in the small mass at the side; *c*, *d*, one joint enlarged, side and dorsal views.
- FIG. 15. Spring Canker-worm (*Anisopteryx vernata*, Peck); *a*, male moth; *b*, female do.—natural size; *c*, joints of her antennæ; *d*, joint of her abdomen, showing spines; *e*, her ovipositor—enlarged.
- FIG. 16. Spring Canker-worm (*Anisopteryx vernata*, Peck); front view of head.
- FIG. 17. Fall Canker-worm (*Anisopteryx pometaria* Harr.); *a*, *b*, egg, side and top views; *c*, *d*, side and top views of one joint of larva,—enlarged; *e*, batch of eggs; *f*, full grown larva; *g*, female chrysalis—natural size; *h*, top view of anal tubercle of chrysalis.
- FIG. 18. Fall Canker-worm (*Anisopteryx pometaria* Harr); *a*, male moth; *b*, female do.—natural size; *c*, joints of her antennæ; *d*, joint of her abdomen—enlarged.
- FIG. 19. Phylloxera, Male (*Phylloxera caryocaulis*, Fitch?).
- FIG. 20. Grafting; *a*, *b*, incisions to receive the scion; *d*, scion; *c*, string to secure scion—to prevent phylloxera injury.
- FIG. 21. Grafting—to prevent phylloxera injury.
- FIG. 22. American Oak Phylloxera (*Phylloxera rileyi* Licht.); *a*, male, ventral view; *b*, genital organ; *c*, tarsus—all greatly enlarged.

- FIG. 23. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a, a, a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open, showing how the eggs are arranged; *c*, a few eggs lying loose on the ground; *d, e*, shows the earth partially removed, to illustrate an egg-mass already in place, and one being placed; *f*, shows where such a mass has been covered up.
- FIG. 24. Rocky Mountain Locust (*Caloptenus spretus* Thomas); anal characters of female, showing horny valves of ovipositor; *b*, an upper valve; *c*, a lower valve—all enlarged.
- FIG. 25. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a, a*, newly hatched larva; *b*, full-grown larva; *c*, pupa.
- FIG. 26. Red-legged Locust (*Caloptenus femur-rubrum*, DeG.).
- FIG. 27. Rocky Mountain Locust (*Caloptenus spretus* Thomas).
- FIG. 28. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a*, tip of abdomen of male, side view; *b, c*, hind and top views of tip—all enlarged.
- FIG. 29. Red-legged locust (*Caloptenus femur-rubrum* DeGeer); *a*, tip of abdomen of male, side view; *b, c*, hind and top view—all enlarged.
- FIG. 30. Migratory Locust of Europe (*Eidipoda migratoria* Linn.).
- FIG. 31 (p. 142). Map of North America, illustrating the country east of the Rocky Mountains subject to the Ravages of the Rocky Mountain Locust.
(Opposite p. 144.) Map of Missouri, illustrating the Locust Invasion of 1874.
- FIG. 32. Swarm of Locusts falling upon and devouring a wheat-field.
- FIG. 33. Differential Locust (*Caloptenus differentialis*, Walk.).
- FIG. 34. Two-striped Locust (*Caloptenus bivittatus*, Say).
- FIG. 35. Silky Mite (*Trombidium sericeum* Say); natural size shown at side.
- FIG. 36. Locust Mite (*Astoma gryllaria* LeBaron); greatly enlarged.
- FIG. 37. Mite parasitic on the House-fly (*Trombidium muscarum* Riley); enlarged.
- FIG. 38. Red-tailed Tachina-fly (*Exorista militaris* Kirkp.)
- FIG. 39. Flesh-fly (*Sarcophaga sarraceniae* Riley); *a*, larva; *b*, pupa; *c*, fly; *d*, head and prothoracic joints of larva, showing curved hooks, lower lip (more enlarged at *g*), and prothoracic spiracles; *e*, end of body of larva, showing stigmata (more enlarged at *f*), prolegs and vent; *h*, tarsal claws of fly with protecting pads; *i*, antenna of fly—all enlarged.
- FIG. 40. Seventeen-year Locust (*Cicada septemdecim* Linn.); one wing removed so as to show ovipositor, *b*; *a*, beak.

REPORT VIII.

- FIG. 1. *Lebia grandis* Hentz.
- FIG. 2. Peck's Spray Machine in operation. [From inventor.]
- FIG. 3. Spring Canker-worm (*Paleacrita vernata*, Peck); *a*, caterpillar; *b*, eggs, natural size, one enlarged; *c*, one joint of larva, enlarged, side view; *d*, same, dorsal view.
- FIG. 4. Fall Canker-worm (*Anisopteryx pometaria* Harr.); *a, b*, egg enlarged, side and top views; *c, d*, joint of larva, enlarged, side and dorsal views; *e*, eggs, natural size; *f*, caterpillar; *g*, female chrysalis; *h*, tip of chrysalis, enlarged.
- FIG. 5. Spring Canker-worm (*Paleacrita vernata*, Peck), female chrysalis, enlarged.
- FIG. 6. Fall Canker-worm (*Anisopteryx pometaria* Harr.); *a*, male, *b*, female chrysalis, enlarged; a dorsal view of the tip of each shown beneath.
- FIG. 7. Spring Canker-worm (*Paleacrita vernata*, Peck); *a, b*, venation of wings; *c*, one joint of male antennæ, greatly enlarged.
- FIG. 8. Fall Canker-worm (*Anisopteryx pometaria* Harr.); *a, b*, venation of wings; *c, d*, one joint of male antennæ, greatly enlarged, side and under views.
- FIG. 9. Spring Canker-worm (*Paleacrita vernata*, Peck); *a*, male moth; *b*, female moth—nat. size; *c*, portion of antenna of female; *d*, one segment of female abdomen; *e*, ovipositor—enlarged.

- FIG. 10. Fall Canker-worm (*Anisopteryx pometaria* Harr.); *a*, male moth; *b*, female moth—nat. size; *c*, joints of female antenna; *d*, one joint of female abdomen—enlarged.
- FIG. 11. Canker-worm Trap, consisting of a band of tin attached to a circle of muslin.
- FIG. 12. Canker-worm Trap, of tin and muslin; section. [From *Country Gentleman*.]
- FIG. 13. Canker-worm Trap, of tin and muslin; section to show the mode of union of the tin and muslin. [From *Country Gentleman*.]
- FIG. 14. Canker-worm Trap, at base of tree—Section. [From *Country Gentleman*.]
- FIG. 15. Canker-worm Trap, at base of tree. [From *Country Gentleman*.]
- FIG. 16. Tent-caterpillar of the Forest (*Clisiocampa sylvatica* Harr.); *a*, eggs; *b*, female moth; *c*, egg, enlarged, top view; *d*, same, side view.
- FIG. 17. Tent-caterpillar of the Forest (*Clisiocampa sylvatica* Harr.).
- FIG. 18. Army-worm (*Leucania unipuncta* Haw.), male genitalia; *A*, end of body denuded of hairs, showing the upper clasps protruding, and the natural position of the hidden organs by dotted lines; *B*, the organs extended; *c*, upper valves; *d*, lower valves; *e*, upper intermediate organ; *f*, penis; *g*, back view of upper intermediate organ; *h*, inner surface of upper valves—all enlarged.
- FIG. 19. Army-worm (*Leucania unipuncta* Haw.); *a*, *b*, end of abdomen of female denuded of scales, showing the ovipositor withdrawn and exerted; *c*, terminal joint of ovipositor; *d*, striations representing folds of the membrane, to facilitate expansion; *e*, *f*, retractile subjoinets; *h*, eggs—all enlarged; *g*, eggs, natural size.
- FIG. 20. Army-worm (*Leucania unipuncta* Haw.), natural size when full grown.
- FIG. 21. Army-worm (*Leucania unipuncta* Haw.), chrysalis.
- FIG. 22. Army-worm (*Leucania unipuncta* Haw.); *a*, male moth; *b*, abdomen of female—nat. size; *c*, eye, *d*, base of male antenna; *e*, base of female antenna—enlarged.
- FIG. 23. Stalk-Borer (*Gortyna nitela* Guen.); *a*, terminal joints of female abdomen denuded to show the exerted ovipositor; *b*, view of the ovipositor from above.
- FIG. 24. Unarmed Rustic (*Agrotis saucia* Treit.); *a*, top view of egg, enlarged; *b*, batch of eggs enlarged. [See Notes, etc., p. 55.]
- FIG. 25. Unarmed Rustic (*Agrotis saucia* Treit.); *a*, ovipositor as it appears at the end of the abdomen; *b*, same when extended.
- FIG. 26. Fall Army-worm (*Laphygma frugiperda*, Sm. & Abb.); *a*, full grown worm, nat. size; *b*, head, front view; *c*, one joint of body, dorsal view; *d*, do., side view—enlarged. [See Notes, etc., p. 56.]
- FIG. 27. Fall Army-worm (*Laphygma frugiperda*, Sm. & Abb.); *a*, the typical form; *b*, *c*, variations of wings.
- FIG. 28. Elongate Ground-beetle (*Pasimachus elongatus* Lec.).
- FIG. 29. Murky Ground-beetle (*Harpalus caliginosus*, Fabr.).
- FIG. 30. Fiery Ground-beetle (*Calosoma calidum*, Fabr.); *a*, larva; *b*, beetle.
- FIG. 31. Rummaging Ground-beetle (*Calosoma scrutator*, Fabr.). [After Harris.]
- FIG. 32. Red-tailed Tachina-fly (*Ezorida leucaniae* Kirk.). [After Walsh.]
- FIG. 33. Yellow-tailed Tachina-fly (*Ezorida flavicauda* Riley).
- FIG. 34. *Microgaster militaris* Walsh. [After Walsh.]
- FIG. 35. Glassy Mesochorus (*Mesochorus vitreus* Walsh). [After Walsh.]
- FIG. 36. *Pezomachus minimus* Walsh. [After Walsh.]
- FIG. 37. *Pezomachus minimus* Walsh, bunch of cocoons. [After Walsh.]
- FIG. 38. *Ophion purgatus* Say.
- FIG. 39. Rocky Mountain Locust (*Caloptenus spretus* Thomas): process of acquiring wings; *a*, pupa with skin just split on the back; *b*, the imago extending; *c*, do., nearly out; *d*, do. with wings expanded; *e*, do. with all parts perfect.
- FIG. 40. *Acridium americanum*, Drury.
- FIG. 41. Coral-winged Locust (*Edipoda phanicoptera* Germ.).

- FIG. 42. White-lined Morning Sphinx (*Deilephila lineata* Fabr.), green larva.
 FIG. 43. White-lined Morning Sphinx (*Deilephila lineata* Fabr.), black larva.
 FIG. 44. White-lined Morning Sphinx (*Deilephila lineata* Fabr.).
 FIG. 45. Lubber Locust (*Brachypeplus magnus* Gir.).
 FIG. 46. Green-striped Locust (*Tragocephala viridifasciata*); a, pupa; b, perfect insect.
 FIG. 47. Granulated Grouse-locust (*Tettix granulata* Scudder).
 FIG. 48. Grape Phylloxera (*Phylloxera vastatrix* Plan.); a, female, ventral view, showing egg through transparent skin; b, do. dorsal view; c, greatly enlarged tarsus; d, shrunken anal joints as they appear after oviposition; e, male of *Ph. caryocaulis*, Fitch †, dorsal view—the dots in circle indicating natural size.
 FIG. 49. Yucca Borer (*Megathymus yuccæ*, Walk.); a, a, funnels made by the larva; b, under ground stem, showing tunnelings of larva.
 FIG. 50. Yucca Borer (*Megathymus yuccæ*, Walk.), female moth.
 FIG. 51. Yucca Borer (*Megathymus yuccæ*, Walk.); a, egg, side view, enlarged; b, egg from which the larva has hatched; bb, bbb, unhatched eggs—natural size; c, newly-hatched larva, enlarged; c c, full grown larva, natural size; d' underside of head of same, enlarged to show the trophi.
 FIG. 52. Yucca Borer (*Megathymus yuccæ*, Walk.), pupa.
 FIG. 53. Yucca Borer (*Megathymus yuccæ*, Walk.), moth walking.
 FIG. 54. Yucca Borer (*Megathymus yuccæ*, Walk.); a, b, venation of front and hind wings; c, labial palpus denuded; d, club of antenna; e, f, g, front, middle and hind legs,—all but wings enlarged.
 FIG. 55. *Castnia phalaris* (Fabr.), venation.

REPORT IX.

- FIG. 1. Gooseberry Span-worm (*Eufitchia ribearia*, Fitch.); a, b, larvæ; c, pupa.
 FIG. 2. Gooseberry Span-worm (*Eufitchia ribearia*, Fitch), female moth.
 FIG. 3. Gooseberry Span-worm (*Eufitchia ribearia*, Fitch); a, egg, enlarged; b, b, eggs, natural size.
 FIG. 4. Imported Currant-worm (*Nematus ventricosus* Klug); currant leaf showing eggs (1), and the holes which the young worms make (2, 3). [From *Practical Entomologist*.]
 FIG. 5. Imported Currant-worm (*Nematus ventricosus* Klug); a, a, a, larvæ; b, side view of one joint, enlarged, showing black tubercles.
 FIG. 6. Imported Currant-worm (*Nematus ventricosus* Klug); a, male fly; b, female fly.
 FIG. 7. Soldier-bug (*Podisus placidus* Uhler); a, enlarged; b, natural size.
 FIG. 8. Ovipositors of Sawflies; a, Willow-apple Sawfly (*Nematus salicis-pomum* Walsh); b, Currant-worm Sawfly (*Nematus ventricosus* Klug.), enlarged.
 FIG. 9. Native Currant-worm (*Pristiphora grossulariæ* Walsh); a, larva, nat. size; b, fly enlarged.
 FIG. 10. Strawberry-worm (*Emphytus maculatus* Nort.); 1, 2, ventral and lateral views of pupa; 3, enlarged sketch of perfect fly, the wings on one side detached; 4, larva crawling, natural size; 5, perfect fly with wings folded, natural size; 6, larva at rest; 7, cocoon; 8, antenna, enlarged; 9, egg, enlarged.
 FIG. 11. Abbot's Pine-worm (*Lophyrus Abbotii* Leach); 1, perfect fly, magnified; the left wings removed; 2, 3, ventral and lateral views of pupa, enlarged; 4, larvæ in different positions, nat. size; 5, cocoon, nat. size; 6, antenna of male, enlarged; 7, antenna of female, enlarged.
 FIG. 12. Map showing the distribution of the Colorado Potato-beetle (*Doryphora decemlineata*, Say).

- FIG. 13. *Uropoda americana* Riley; *a*, Colorado Potato-beetle attacked by it—nat. size; *b*, the mite, ventral view, showing the penetrating organ lying between the legs; *c*, the organs extended; *d*, the claw; *e*, the excrematitious filament—all greatly enlarged.
- FIG. 14. Wheat-head Army-worm (*Leucania albilinea* Guen.); *a*, *a*, larvæ; *b*, eggs—nat. size; *c*, *d*, egg, top and side view—enlarged.
- FIG. 15. Wheat-head Army-worm moth (*Leucania albilinea* Guen.).
- FIG. 16. Map of North America, illustrating the country east of the Rocky Mountains overrun by the Rocky Mountain Locust in 1876.
- FIG. 17. *Acridium americanum*, Drury.
- FIG. 18. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end; *c*, a few eggs lying loose on the ground; *d*, *e*, shows the earth partially removed, to illustrate an egg-mass already in place and one being placed; *f*, shows where such a mass has been covered up.
- FIG. 19. Rocky Mountain Locust (*Caloptenus spretus* Thomas); Anal characters of female, showing horny valves of ovipositor; *b*, an upper valve; *c*, lower valve—all enlarged.
- FIG. 20. Rocky Mountain Locust (*Caloptenus spretus* Thomas); oviposition—*i*, super-anal plate; *h*, sponge-like exsertile organ—the egg passing through the horny valves of the ovipositor, *g*.
- FIG. 21. Rocky Mountain Locust (*Caloptenus spretus* Thomas), egg-mass, enlarged; *a*, side view within burrow, the line of exit of the young locusts shown at *d* and *e*; *b*, egg-mass from beneath; *c*, same from above.
- FIG. 22. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a*, egg, enlarged to show sculpture of outer shell; *b*, portion of same very highly magnified; *c*, the inner shell, just before hatching; *d*, *e*, points where it ruptures.
- FIG. 23. Anthomyia Egg-parasite (*Anthomyia radicum*, Linn., var. *calopteni* Riley); fly; *b*, puparium; *c*, larva, side view; *d*, head of same, from above—enlarged.
- FIG. 24. Bombyliid larva (*Systæchus* sp.); *a*, enlarged; *b*, head, side view, more enlarged; *c*, do., front view; *d*, posterior spiracle. [See Notes, etc., p. 60.]
- FIG. 25. Harpalus? larva; *a*, from above; *b*, head, from beneath; *c*, leg—enlarged; *d*, antenna; *e*, maxilla; *f*, labium.
- FIG. 26. Harpalus? larva; *A*, natural size; *B*, under side of head, enlarged; *c*, mandible; *e*, antenna; *f*, labium and labial palpi; *g*, maxilla and maxillary palpi; *h*, joint 12 beneath; *i*, joint 11 beneath; *j*, joints 4-10 each beneath—enlarged.
- FIG. 27. Pennsylvania Ground-beetle (*Harpalus pensylvanicus*, DeGeer).
- FIG. 28. *Erax bastardi* Macq.; *a*, larva; *b*, pupa.
- FIG. 29. *Amblychila cylindricornis* Say.
- FIG. 30. Hellgrammite (*Corydalus cornutus*, Linn.); *a*, larva; *b*, pupa; *c*, fly, male; *d*, head of female fly.
- FIG. 31. Hellgrammite (*Corydalus cornutus*, Linn.); *a*, *a*, egg-masses attached; *b*, one detached, showing lower surface,—all rather below average size; *c*, a few eggs of the outer row; *d*, the newly-hatched larva; *e*, labium; *f*, antenna; *g*, maxilla; *h*, mandible; *i*, tarsal claw; *j*, anal hooks—all enlarged.
- FIG. 32. Eggs of *Belostoma*?
- FIG. 33. Gigantic Water-bug (*Belostoma grandis* Linn.).

CLASSIFIED LIST OF ILLUSTRATIONS.

The following list of illustrations, brought together in classificatory order, will prove serviceable to entomologists, as it will enable such to readily ascertain whether or not any particular insect of a particular Order has been figured in the Reports. The explanations to the figures are omitted, since they are already given in the preceding list. The nomenclature of the Reports is here, also, retained, and references to figures other than those of insects or their products are omitted. The number of the Report is indicated in Roman and of the figure in Arabic numerals.

HYMENOPTERA.

Ovipositors of Sawflies: IX, 8.
Pristiphora grossulariæ *Walsh*: IX, 9.
Nematus ventricosus *Klug*: IX, 4, 5, 6.
Emphytus maculatus *Nort.*: IX, 10.
Lophyrus Abbotii *Leach.*: IX, 11.
Aphelinus mytilaspidis *LeBaron*: V, 34.
Trichogramma ? *minuta* *Riley*: III, 72.
Antigaster mirabilis *Walsh*: VI, 48, 49.
Chalcid sp.: I, pl. 2, Fig. 6.
Glyphe viridascens *Walsh*: II, 24.
Isosoma vitis *Saunders*: I, 73; II, 64.
Isosoma hordei *Harr.*: II, 65.
Eurytoma bolteri *Riley*: I, pl. 2, Figs. 8, 9; I, 97.
Chalcis albifrons *Walsh*: II, 22.
Chalcis mariæ *Riley*: IV, 39.
Microgaster (= *Apanteles*): II, 48.
Microgaster cocoons on Hog-caterpillar of the Vine (*Chær. pampinatrix*, *Sm. & Abb.*): II, 47.
Microgaster militaris *Walsh*: I, 32; II, 23; III, 73; VIII, 34.
Aleiodes *Riley*: III, 30.
Bracon charus *Riley*: VII, 13.
Macrocentrus delicatus *Cress.*: V, 27.
Sigalphus curculionis *Fitch*: III, 7, 8.
Pimpla annulipes *Br.*: V, 26.
Cryptus samia *Pack.*: IV, 40, 41.
Hemiteles (?) *cressonii* *Riley*: I, pl. 2, Fig. 7.

Hemiteles (?) *thyridopterygis* *Riley*: I, pl. 2, Figs. 10, 11, 12.
Pezomachus minimus *Walsh*: II, 20, 21; VIII, 36, 37.
Porizon conotracheli *Riley*: III, 9.
Mesochorus vitreus *Walsh*: II, 19; VIII, 35.
Ophion macrurum (*Linn.*): IV, 37, 38.
Ophion purgatus *Say*: II, 25; VIII, 38.
Tiphia inornata *Say*: VI, 34.
Ammophila pictipennis *Walsh*: V, 73.
Stizus grandis *Say*, ♀: I, 12.
Eumenes fraterna *Say*: II, 71.
Polistes rubiginosus *St. Farg.*: V, 28.
Vespa maculata *Linn.*: V, 2.

COLEOPTERA.

Amblychila cylindriformis *Say*: IX, 29.
Tetracha virginica *Hope*: I, 59.
Calosoma scrutator (*Fabr.*): II, 69; III, 54; VIII, 31.
Calosoma calidum (*Fabr.*): I, 34, 60; II, 70; VIII, 30.
Pasimachus elongatus *Lec.*: I, 61; VIII, 28.
Aspidoglossa subangulata *Chaud.*: I, 21.
Lebia grandis *Hentz*: III, 41; VIII, 1.
Harpalus caliginosus *Say*: I, 62; VIII, 29.
Harpalus pensylvanicus (*DeGeer*): I, 23; IX, 27.
Harpalus ? larva: I, 22; IX, 25, 26.
Quedius molochinus (*Grav.*): IV, 12.

- Gœrius olens*: IV, 11.
Philonthus apicalis (Say): IV, 10.
Dermestes lardarius Linn.: VI, 27.
Hippodamia maculata (DeGeer): I, 29; II, 3; VII, 5.
Hippodamia convergens Guer.: I, 52; VI, 11.
Hippodamia glacialis (Fabr.): IV, 5.
Hippodamia 13-punctata (Linn.): I, 51.
Coccinella 9-notata Herbst: I, 50.
Coccinella munda Say: II, 4; VII, 6.
Coccinella picta Randall: V, 37.
Mysia 15-punctata (Oliv.): IV, 4.
Chilocorus bivulneris Muls.: I, 4, 5.
Ladybird larva: I, 53.
Passalus cornutus Fabr.: IV, 62.
Macroductylus subspinosus (Fabr.): V, 39.
Lachnosterna quercina (Knoch): I, 88.
White Grub attacked by fungus: I, 89.
Pelidnota punctata (Linn.): III, 34.
Cotalpa lanigera (Linn.): V, 3.
Chrysobothris femorata (Fabr.): I, 15, 16; VII, 12.
Chauliognathus pensylvanicus (DeGeer): I, 19; IV, 14.
Telephorus bilineatus (Say): IV, 15.
Corynetes rufipes (Fabr.): VI, 26.
Sinoxylon basilare (Say): IV, 26, 27.
Bostrichus bicaudatus (Say): IV, 24.
Orthosoma cylindricum (Fabr.): I, 69.
Prionus laticollis (Drury): I, 67; II, 60, 61, 62.
Prionus imbricornis (Linn.): II, 63.
Saperda bivittata Say: I, 14.
Bruchus pisi Linn.: III, 15, 16, 17.
Bruchus granarius Linn.: III, 18.
Bruchus fabæ Riley: III, 19.
Lema trilineata (Oliv.): I, 42, 43.
Coscinoptera dominicana (Fabr.): VI, 36.
Chlamys plicata (Oliv.): VI, 37.
Fidia viticida Walsh: I, 75.
Colaspis flavida Say: III, 37, 38; IV, 16.
Doryphora 10-lineata Say: I, 46.
Doryphora juncta (Germar): I, 47.
Diabrotica 12-punctata (Oliv.): II, 42.
Diabrotica vittata (Fabr.): I, 44; II, 39, 40, 41.
Haltica chalybea Illiger: III, 35, 36.
Haltica cunmeris Harr.: I, 45.
Blepharida rhois (Forst.): VI, 33.
Chelymorpha cribraria (Fabr.): II, 28, 29.
Physonota quinquepunctata Walsh & Riley: II, 30.
Cassida nigripes Oliv.: II, 37, 38.
Cassida bivittata Say: II, 27, 32.
Cassida aurichalcea (Fabr.): II, 31, 33, 34.
Cassida guttata Oliv.: II, 35, 36.
Deloyala clavata (Oliv.): II, 26.
Larva of Tenebrionid (?): VI, 32.
Lytta cinerea Fabr.: I, 40.
Lytta vittata Fabr.: I, 39.
Lytta marginata Fabr.: I, 41.
Epicærus imbricatus (Say): III, 21.
Ithycerus novæboracensis (Forster): III, 20.
Anthonomus prunicida Walsh: III, 13.
Anthonomus quadrigibbus Say: III, 10, 11.
Conotrachelus nenuphar (Herbst): I, 18; III, 1.
Conotrachelus cratægi Walsh: III, 12.
Analcis fragariæ Riley: III, 14.
Cœliodes inæqualis (Say): I, 70, 71, 72.
Baridius trinotatus Say: I, 37.
Baridius sesostris Lec.: I, 74.
Eupsalis minuta (Drury): VI, 31.
Sphenophorus zææ Walsh: III, 22.
Sphenophorus pulchellus Schæn.: III, 23.
Scolytus caryæ Riley: V, 38.

LEPIDOPTERA.

- Papilio philenor* Drury: II, 84, 85, 86.
Pieris protodice Boisd.: II, 72, 73, 74.
Pieris oleracea Boisd.: II, 75, 76.
Pieris rapæ Schrænk.: II, 77, 78, 79.
Danaïs archippus (Fabr.): III, 63, 64, 65, 66, 67.
Limenitis disippus (Godt.): III, 68, 69, 70.
Apatura lycaon (Fabr.): VI, 39, 40.
Apatura herse (Fabr.): VI, 41, 42.
Paphia glycerium Doubl.: II, 94, 95, 96; V, 72.
Megathymus yuccæ Walk.: VIII, 51, 52, 53, 54.
Castnia phalaris (Fabr.) venation: VIII, 35.
Thyreus abboti Swainson: II, 54.
Deilephila lineata (Fabr.): III, 60, 61, 62; VIII, 42, 43, 44.
Chæroampa pampinatrix (Sm. & Abb.): II, 44, 45, 46.
Philampelus satellitia (Linn.): II, 52, 53.
Philampelus achemon (Drury): II, 49, 50, 51.
Sphinx 5-maculata Haw.: I, 38.
Ægeria exitiosa Say: I, 17.
Ægeria polistiformis Harr.: III, 33.
Ægeria rubi Riley: VI, 30.
Ægeria acerni (Clem.): VI, 29.
Allypia octomaculata (Fabr.): I, pl. 1, Fig. 18; II, 55; VI, 25.

- Psychomorpha epimenis* (*Drury*): I, pl. 1, Fig. 19; III, 26; VI, 20, 21.
Eudryas unio (*Hüb.*): II, 57; VI, 24.
Eudryas grata (*Fabr.*): II, 56; VI, 22, 23.
Procris americana *Boisd.*: II, 58, 59.
Deiopeia bella (*Drury*): V, 4.
Callimorpha fulvicosta *Clem.*: III, 56.
Arctia isabella (*Smith*): IV, 65.
Spilosoma virginica (*Fabr.*): III, 28.
Hyphantria textor *Harr.*: III, 55.
Epantheria scribonia (*Stoll*): IV, 63, 64.
Orgyia leucostigma (*Sm. & Abb.*): I, 81, 82, 83.
Thyridopteryx ephemeræformis *Haw.*: I, 84.
Bombyx mori *Linn.*: IV, 29, 30, 31, 32.
Attacus polyphemus *Linn.*: IV, 50, 51, 52, 53, 54.
Attacus luna *Linn.*: IV, 47, 48, 49.
Attacus yama-mai (*Guér-Mén.*): IV, 55, 56, 57, 58.
Attacus Pernyi (*Guér-Mén.*): IV, 60, 61.
Attacus cynthia (*Hüb.*): IV, 42.
Attacus promethea *Drury*: IV, 43, 44, 45, 46.
Attacus cecropia *Linn.*: IV, 33, 34, 35, 36.
Hemileuca maia (*Drury*): V, 60, 61, 62.
Hyperchiria io (*Fabr.*): V, 63, 64, 65, 66.
Dryocampa rubicunda (*Fabr.*): V, 67.
Clisiocampa americana *Harr.*: III, 50, 51; V, 29.
Clisiocampa sylvatica *Harr.*: II, 11; III, 52, 53; VIII, 16, 17.
Acronycta populi *Riley*: II, 87, 88.
Acronycta obliqua (*Sm. & Abb.*): III, 29.
Agrotis subgothica (*Haw.*): I, 29.
Agrotis jaculifera *Guen.*: I, pl. 1, Fig. 11.
Agrotis scandens *Riley*: I, pl. 1, Figs. 5, 6, 7.
Agrotis cochrani *Riley*: I, 26.
Agrotis inermis *Harr.*: I, pl. 1, Figs. 1, 2, 3, 4.
Agrotis sancia *Treit.*: III, 49; VIII, 24, 25.
Agrotis telifera *Harr.*: I, pl. I, Figs. 8, 9, 10; I, 28.
Noctua claudestina *Harr.*: I, pl. I, Fig. 13; I, 27.
Hadena subjuncta *Gr. & Rob.*: I, pl. I, Figs. 14, 15, 16, 17.
Agrotis devastator (*Brace*): I, 30.
Pupa of Cut-worm in earthen cell: I, 25.
Mamestra picta *Harr.*: II, 82.
Celæna renigera *Steph.*: I, 83.
Prodenia commelinæ (*Sm. & Abb.*): I, pl. I, Fig. 12; III, 48.
Gortyna nitela *Guen.*: I, 35, 36; VIII, 23.
Lencania albilinea *Guen.*: IX, 14, 15.
Lencania unipuncta *Haw.*: II, 14, 15, 16; III, 47; VIII, 18, 19, 20, 21, 22.
Prodenia autumnalis *Riley*: III, 45, 46; VIII, 26, 27.
Amphipyra pyramidoides *Guen.*: III, 31, 32.
Anomis xyliana (*Say*): II, 12, 13.
Xyliana cinerea *Riley*: III, 57.
Plusia brassicæ *Riley*: II, 81.
Heliothis armigera *Hüb.*: III, 42, 43.
Anisopteryx pometaria *Harr.*: VII, 17, 18; VIII, 4, 6, 8, 10.
Paleacrita vernata (*Peck*): VII, 14, 16; VIII, 3, 5, 7, 9.
Aplodes rubivora *Riley*: I, pl. 2, Fig. 25.
Hæmatopis grataria (*Fabr.*): I, pl. 2, Figs. 18, 19, 20, 21.
Eufitchia ribearia (*Fitch*): IX, 1, 2, 3.
Asopia costalis (*Fabr.*): VI, 28.
Pempelia Hammondi *Riley*: IV, 21.
Pempelia grossulariæ *Pack.*: I, pl. 2, Fig. 17; I, 79.
Phycita nebulo *Walsh*: IV, 18, 19.
Acrobasis juglandis *LeBaron*: IV, 20.
Galleria cereana *Fabr.*: I, 92.
Desmia maculalis *Westw.*: III, 24.
Phacellura nitidalis *Cram.*: II, 43.
Tortrix cinderella *Riley*: IV, 22.
Tortrix rileyana *Grote*: I, pl. 2, Figs. 3, 4; I, 85.
Penthina vitivorana *Pack.*: I, pl. 2, Figs. 29, 30; I, 76.
Euryptychia saligneana *Clem.*: II, 99.
Carpocapsa pomonella (*Linn.*): I, 24.
Anchylopera fragariæ *Walsh & Riley*: I, pl. 2, Figs. 26, 27; I, 80.
Pronuba yuccasella *Riley*: V, 74, 75; VI, 38.
Walshia amorphella *Clem.*: II, 98.
Gelechia gallæsolidaginis *Riley*: I, pl. 2, Figs. 1, 2; I, 96.
Holcocera glandulella *Riley*: IV, 66.
Bucculatrix pomifoliella *Clem.*: IV, 23.
Pterophorus periscelidactylus *Fitch*: I, pl. 2, Figs. 15, 16; III, 27.
Pterophorus cardui *Riley*: I, pl. II, Figs. 13, 14; I, 98.

HETEROPTERA.

- Corimelæna pulicaria* (*Germar*): II, 9; VII, 11.
Stiretrus fimbriatus (*Say*): I, 5, 6; II, 10.
Perillus circumcinctus *Stål*: IV, 6.

Arma spinosa Dallas : I, 33, 54; II, 7; IV, 8, 9.
Podisus placidus Uhler : IX, 7.
Euschistus punctipes, Say : IV, 7; V, 5.
Strachia histrionica Hahn : IV, 17.
Coreus tristis (DeGeer) : I, 55.
Nysius destructor Riley : V, 41; VII, 9.
Micropus leucopterus (Say) : II, 1, 2; V, 40; VII, 2, 3, 4.
Campyloneura vitripennis (Say) : III, 58, 59.
Capsus oblineatus Say : II, 83.
Anthocoris insidiosus (Say) : II, 6; VI, 14; VII, 7.
Reduvius raptatorius Say : I, 58.
Harpactor cinctus (Fabr.) : I, 57; VII, 8.
Piesma cinerea (Say) : II, 8; VII, 10.
Belostoma grandis Linn. : IX, 33.

HOMOPTERA.

Cicada septemdecim Linn. : I, 6, 7, 13; VII, 40.
Cicada tredecim Linn. : I, 11.
Ceresa bubalus (Fabr.) : V, 6, 50, 51, 52.
Pæcilopectera pruinosa (Say) : V, 54, 55.
Pemphigus vagabundus (Walsh) : I, 65.
Eriosoma pyri Fitch : I, 64.
Phylloxera vastatrix Planchon : III, 39, 40; IV, 28; V, 30; VI, 2, 3, 4, 5, 6, 7, 8; VIII, 48.
Phylloxera caryæcanalis (Fitch)† : VII, 19.
Phylloxera rileyi Liehn. : VI, 18, 19; VII, 22.
Aspidiotus conchiformis (Gmêlin) : I, 2, 3; V, 31.
Mytilaspis pomicorticis Riley : I, 2, 3; V, 31, 32.
Aspidiotus harrisii (Walsh) : I, 1.
Mytilaspis pinifoliae (Fitch) : V, 35, 36.

DIPTERA.

Gall, *Vitis-tomatos Riley*=*Lasioptera vitis O. S.* : V, 45.
Gall, *Vitis-viticola Riley*=*Cecidomyia viticola O. S.* : V, 46.
Gall, *Cecidomyia salicis-strobiloides Walsh* : V, 43.
Gall, *Vitis-coryloides W. & R.* : V, 44.
Gall, *Vitus-pomum W. & R.* : V, 42.
Tabanus atratus Fabr. : II, 97.
Wing of *Promachus (a)*, *Asilus (b)*, *Erax (c)* : II, 90.
Trupanea apivora Fitch : I, 93.
Erax bastardi Macq. : II, 92, 93; IX, 28.

Asilus missouriensis Riley : II, 89; V, 7.
Asilus sericeus Say : II, 91.
Bombyliid larva (Systoechus sp.) : IX, 24.
Pipiza radicum W. & R. : I, 66; VI, 15.
Syrphus larva : VI, 12.
Helophilus latifrons Loew : VI, 13.
Cestrus ovis Linn. : I, 91.
Exorista leucaniae Kirk. : II, 17; VII, 33; VIII, 32.
Exorista flavicauda Riley : II, 18; VIII, 33.
Lydella doryphoræ Riley : I, 48.
Belvoisia bifasciata (Fabr.) : V, 68.
Sarcophaga sarcacenæ Riley : VII, 39.
Anthomyia radicum (Linn.), var. *calopteni Riley* : IX, 23.
Anthomyia zee Riley : I, pl. II, Fig. 24; I, 86, 87.
Meromyza americana Fitch : I, pl. II, Fig. 28; I, 90.

ORTHOPTERA.

Ecanthus niveus Harr : I, 77, 78; V, 49.
Orocharis saltator Uhler : V, 47, 48.
Phaneroptera curvicauda (DeGeer) : VI, 50, 51.
Phylloptera oblongifolia (DeGeer) : VI, 55.
Microcentrus retinervis (Burm.) : V, 57, 58; VI, 43, 44, 45, 46, 47.
Platyphyllum concavum Harr : V, 59; VI, 52, 53, 54.
Orchelimum glaberrimum (Burm.) : V, 56.
Acridium americanum (Drury) : VIII, 40; IX, 17.
Caloptenus spretus Thomas : VII, 23, 24, 25, 27, 28; VIII, 39; IX, 18, 19, 20, 21, 22.
Caloptenus femur-rubrum, DeG. : VII, 26, 29.
Caloptenus differentialis Walk. : V, 8; VII, 33.
Caloptenus bivittatus (Say) : VII, 34.
Brachyepplus magnus Gir. : VIII, 45.
Ædipoda migratoria Linn. : VII, 30.
Ædipoda phœnicoptera Germ. : VIII, 41.
Tragocephala viridifasciata Harr. : VIII, 46.
Tettix granulata Scudder : VIII, 47.
Mantis carolina (Linn.) : I, 94, 95.

NEUROPTERA.

Libellula trimaculata (DeGeer) : V, 9.
Corydalus cornutus (Linn.) : V, 69, 70, 71; IX, 30, 31.
Chrysopa sp. : I, 20; II, 5; VI, 10.
Thrips sp. : VI, 9.

ARACHNIDA.

Phalangium dorsatum Say : IV, 3.

ACARINA.

Trombidium muscarum Riley : VII, 37.

Trombidium sericeum Say : VII, 35.

Tyroglyphus phylloxeræ Planchon & Riley :
VI, 16.

Nothrus ovivorus Pack. : II, 68.

Leptus irritans Riley and *L. americanus*
Riley : VI, p. 122.

Uropoda americana Riley : IX, 13.

Dermaleichus ? : V, 33.

Astoma gryllaria LeBaron : VII, 36.

Hoplophora arctata Riley : VI, 17.

GENERAL INDEX.

In this general index each report is referred to in Roman and the page in Arabic numerals. The index to the new matter of this Bulletin is also included and referred to by the abbreviation "Supp."

A.

Abbot Sphinx, II, 78
Abbotii, *Lophyrus*, IX, 82, Supp., 65
Thyreus, II, 78
Abbott's White Pine Worm, IX, 29
 Descriptive, IX, 32.
 Natural History, IX, 30
 Natural Enemies, IX, 31
 Remedies, IX, 32
Abraxas grossulariata, IX, 5
Acarus mali, II, 6
mali, I, 16, V, 87
scabiei, VI, 61
Walshii, V, 87
acricola, *Acronycta*, II, 121
acerni, *Aegeria*, VI, 107, 108, Supp., 55
Trochilium, VI, 108
achemon, *Philampelus*, II, 74
Achemon Sphinx, II, 74, 78
Ackroptera, a proposed order of insects, V, 16
Acidalia persimilata, VI, 138
Acodithus falsarius, II, 86
Acorn Moth, IV, 144
Acridida, Stridulation of, VI, 153
Acridii, VIII, 115, 128
Acridium americanum, VII, 173, 174, VIII, 103, 104, IX, 84
peregrinum, VII, 123, VIII, 144, 145
epretis, VII, 128
epretum, VIII, 128
Acridophagi, VIII, 144
Acrobasis, IV, 46
consociella, IV, 45
Hammondii, III, 7
juglandis, IV, 42, 48, V, 49, Supp., 67, 80
nebuli, IV, 38, 47, Supp., 79, 80
nebulella, IV, 42, Supp., 80
Acronycta, II, 119
americana, II, 121, Supp., 73, 74
interrupta, II, 121, Supp., 73
leporina, II, 121, Supp., 73
lepusculina, II, 121, Supp., 73, 74
leuticocoma, V, 126
oblinita, III, 70, 71, V, 126
occidentalis, II, 121, V, 126, Supp., 73
populi, II, 119, 120, Supp., 72, 74
psi, II, 121, Supp., 73
tridens, II, 121, Supp., 73
zylinoidea, V, 126
acronycta, *Microgaster*, II, 120
Act to provide for the destruction of Locusts in Minnesota, IX, 114

Act to encourage the destruction of Locusts in Missouri, IX, 111
Acts to provide for the destruction of Locusts in Kansas, IX, 112, 113
Actias luna, IV, 123
Aculeata, a section of Hymenoptera, V, 9
Address before the Farmers of Cass County, Missouri, VIII, 66
Address before the National Agricultural Congress, VI, 17
Adephaga, a section of carnivorous beetles, V, 11
Adkins, F. D., Experience of, with Rocky Mountain Locust, VIII, 126
Adkins, James, Report on Rocky Mountain Locust, IX, 74
Adoneta, VI, 140
spinuloides, V, 126
adonidium, *Coccus*, III, 96
Aegeria, VI, 108
acerni, VI, 107, Supp., 55
cucurbitae, II, 64
exitiosa, I, 47
poliatiiformis, I, 127, III, 75, 76
rubri, VI, 111, 113, Supp., 73
tipuliiformis, II, 10, VI, 108, IX, 2
Aegerida, V, 41
Aegiale, VIII, 170
indecisa, VIII, 179
Kollar, VIII, 179
aeaea, *Lytta*, III, 6
aëqua, *Agrotis*, I, 74
Æschna, Oviposition of, VIII, 37
æscularia Anisopteryx, VIII, 17, Supp., 56
æstiva, *Dendroica*, VI, 27
Affleck, Thos., on Cotton Worm, II, 38, 40, VI, 84
 Rocky Mountain Locust, VII, 189, 191
afusana, *Pædicca*, Supp., 67
Agassiz, Professor, on mimicry, III, 73
Agelaius phænicus, VI, 27
Ageratum, VI, 188
Aglaope americana, II, 85
Agriculture, relation of insects to, V, 18
Agriion, oviposition of, VIII, 36
Agrotis, I, 68, Supp., 55
aëqua, I, 74
Cochranii, I, 74, Supp., 76, 77
cursoria, I, 78
devastator, I, 83, Supp., 56
herilis, Supp., 55
inermis, I, 72, 74, II, 50, III, 15, 114, 129
 VII, 37, Supp., 55

- Agrotis jaculifera*, I, 82, 83, Supp., 56
lycarum, Supp., 77
maizi, I, 81
messoria, Supp., 77
murænula, I, 78
nigricans, I, 81, 83, 87
ortonii, Supp., 55
repentis, Supp., 77
saucia, I, 74, Supp., 55
scandens, I, 76, 78, III, 6, Supp., 75
subgothica, I, 81, 83, III, 151, Supp., 55, 56
sufusa, Supp., 55
teñifera, I, 80, Supp., 55
trícosa, Supp., 55
ypsilón, Supp., 55
- Allanthus Silkworm, IV, 112
 Best method of raising, IV, 119
 Difference between Castor bean and Allanthus Worms, IV, 112
 Larval changes, IV, 117
 Natural History of, IV, 117
 Retrospective History of, IV, 113
 Thoroughly acclimated in America, IV, 115
 Value of the Cocoon, IV, 115
 When introduced into America, IV, 114
- Allanthus Worm, I, 151
alabama, *Chrysobothris*, VII, 71
Albany Argus, article from, on Army Worm, II, 43, VIII, 26
albifrons, *Chalcis*, II, 52, VIII, 54
albilinea, *Leucania*, IX, 55
aldivenorus, *Micropus*, VII, 22
albolineata, *Synchlora*, Supp., 79
alboscutellatus, *Bruchus*, Supp., 71
aloeæ, *Erynnis*, VIII, 182
Aleochara anthomyia, IV, 22
Aleiodes Rileyi, III, 71
Aletia argillacea, VIII, 23, Supp., 56
alicia, *Apatura*, VI, 145, 150
 Alkalies for Grape-vine Root-lice, IV, 69
 Allen, T. R., Experience of, with Grass Cut-worm, I, 80
 on Army Worm, II, 47, VIII, 52
 Wheat Cut Worm, I, 87
- Allen, G. W., on Rocky Mountain Locust, VIII, 102
Altica virginica, VI, 122
Alucitidae, III, 67
Alypia octomaculata, I, 136, II, 80, 82, VI, 88, 94, 95
Amara angustata, VIII, 52
 obesa, Supp., 52
ambiguella, *Onchylia*, Supp., 57
Amblychila cylindriciformis, IX, 98
Ambulatoria, a division of Orthopterous insects, V, 14
americana, *Acronycta*, II, 121, Supp., 73, 74
 Aglaope, II, 85
 Apatela, II, 121, Supp., 73, 74
 Oliotocampa, II, 7, III, 117
 Olostera, II, 19, VII, 27
 Otenucha, II, 85
 Meromyza, I, 59
 Parula, VI, 27
 Procris, II, 85
 Silpha, VI, 100
 Tropoda, IX, 41
- American Acridium, VIII, 108, IX, 84
Agriculturist, article from, on grasshoppers, VII, 172
 article from, on Remedy for Currant Worm, IX, 15
 article from, on Yucca fertilization, V, 159
- Bacon-beetle, VI, 100
 Bean-weevil, III, 52
 Blight, III, 95, IX, 43
 Carrion-beetle, VI, 100
 Copper Underwing, III, 72
 Cuckoo, III, 121
Entomologist, article from, on Bean weevil, III, 53
 article from, on Colorado Potato-beetle, III, 97
 article from, on Curculio extermination, III, 15
 article from, on imported and native insects, II, 8
 article from, on Strawberry Leaf-roller, I, 142
- Meat Worm, IX, 43
 Meromyza, I, 159, II, 16
Naturalist, article from, on Birds destroying Canker Worm, VI, 27
 article from, on injury caused by *Allypia*, II, 81
- Oak Phylloxera, VI, 64, VII, 99, 118, VIII, 158
 Plants and Insects acclimated in Europe, IX, 43
 Procris, II, 85, 86, 87
 Silk-worm, IV, 104
 Tent-caterpillar, eggs of, V, 55
 Timber-beetle, III, 7
 vines, first suggestion to use in France as a remedy for Phylloxera, IV, 62
 vines in France, VI, 79
- americanum*, *Acridium*, VII, 173, 174, VIII, 108, 104, IX, 84
americanus, *Chauliognathus*, Supp., 53
 Coccyzus, III, 121, VIII, 124
 Hyleocetus, III, 7
Ammophila pictipennis, V, 149
amœnum, *Callidium*, IV, 54
amorphella, *Walshia*, II, 182, 183
Ampelis cedrorum, VI, 27
 garrulus, VII, 90
Ampelogypter sesostris, Supp., 71
ampelopsis, *Madarus*, I, 182
Amphicercus bicaudatus, IV, 51, V, 54
Amphipyra conspersa, III, 75, Supp., 75
 inornata, III, 75
 pyramidea, III, 73, 74
 pyramidoidea, III, 72, 74, Supp., 75
- Amphydasis cognataria*, IX, 7
 Amputating Brocade-moth, I, 87
amputatrix, *Hadena*, I, 87
Amydria, V, 151
Analcis, III, 44
 fragariae, III, 42, 44, Supp., 71
Anaphora, V, 151

- Anasa*, Supp., 58
Anatis, Supp., 53
Anchylopera comptana, I, 143
 fragariae, I, 142, Supp., 57
 Andrews, W. V., on Eight-spotted Forester, II, 81
Angerona crocatoria, IX, 7
 Angular-winged Katydid, VI, 155
 Description of immature Stages, VI, 161
 Natural Enemies, VI, 162
angulifera, *Collosamia*, IV, 122, 128, Supp., 55
 Angus, Jas., on Bean weevil, III, 52
angustata, *Amara*, VIII, 52
angustatus, *Nysius*, Supp., 85
angustifrons, *Anthomyia*, Supp., 89
 Animal Kingdom, Classification of, V, 6
Anisonyx rufa, VI, 143
Anisopteryx æscularia, VIII, 17, Supp., 56
 pometaria, II, 97, VI, 29, VII, 80, 83,
 86, VIII, 13, Supp., 56
 vernata, I, 109, II, 94, VI, 28, VII, 80,
 86
Anisota rubicunda, V, 137, 140
 stigma, V, 126
Anobium, III, 7, VI, 101
Anomalon apicale, IX, 55
 flavicornis, III, 69
Anomia, VI, 24
 xylina, II, 37, V, 19, VI, 17, VIII, 23,
 Supp., 56
anonyma, *Tachina*, IV, 129, V, 133, VII, 178, VIII,
 179
 Anonymous *Tachina*-fly, VII, 178
Annelida, V, 6, 7.
annulata, *Brochymena*, IV, 20
annulipes, *Pimpla*, IV, 43
Antheræa, IV, 114
 Pernyi, IV, 137
 Paphia, IV, 138
 yama-mai, IV, 130
Anthocoris, VII, 47
 insidiosus, II, 27, 32, VI, 51, VII, 41,
 Supp., 58
Anthomyia, III, 150
 angustifrons, Supp., 89
 brassicae, I, 156, IV, 22, 35, IX, 95
 ceparum, I, 155, II, 9, IX, 95
 radicum, IX, 92, Supp., 88
 var. *calopteni*, IX, 92, Supp.,
 88
 raphani, IX, 95
 zeæ, I, 154, Supp., 89
Anthomyia Egg-parasite of Locust, IX, 92
anthomyia, *Aleochara*, IV, 22
Anthonomus pomorum, III, 11
 prunicida, III, 39, Supp., 54
 pyri, III, 11
 quadrigibbus, III, 29, 35
 scutellaria, Supp., 54
 signatus, V, 154
 suturalis, III, 60
 Anthony, J. M., on Army Worm, VIII, 39
Anthribus varius, III, 10
 Antidote for Paris green, IV, 13
Antigaster mirabilis, VI, 162, 163, Supp., 52
Anta, V, 9
Apanteles, Supp., 52, 66
Apatele americana, II, 121, Supp., 73, 74
Apatura alicia, VI, 145, 150
 celtis, VI, 139, 142, 150
 clyton, 142, 150
 herse, VI, 136, 137, 140, 148, 150
 idyja, VI, 145
 iris, VI, 136
 lycaon, VI, 136, 137, 146, 150
 proserpina, VI, 145, 150
Aphaniptera, V, 15
Aphelinus mytilaspis, V, 88, 100
Aphidæ, V, 68, 85, VII, 27
 Aphidian Hickory galls, V, 154
Aphididae, VI, 31, 33
Aphis, II, 19, III, 96, V, 149
 avenæ, II, 5, 6, 10
 brassicae, II, 10, IV, 36
 mali, II, 6, 10, III, 6
 ribesii, VI, 46
 ribis, II, 10, IX, 2
 vitis, I, 13
Aphis, Currant, VI, 46
 Wooly, IV, 100
Aphodius, VI, 124
apiarius, *Olerus*, VI, 101
apicale, *Anomalon*, IX, 55
apicalis, *Philonthus*, IV, 21
Apiomerus, IX, 98
Apion apricans, III, 11
Apis mellifica, V, 18
apivora, *Trupanea*, I, 168, II, 122, Supp., 60
Aplodontia leporina, VI, 144
Aplodes rubivora, I, 139, Supp., 79
 Apple Bud-moth, III, 6
 Curculio, III, 6, 29, 30, 32, 33, 39
 Its natural history, III, 30
 It transforms in the fruit, III, 31
 Remedies, III, 34
 Season during which it works, III, 34
 The amount of damage it does, III, 33
 gall, Grape-vine, V, 114
 growing on Grape-vine, V, 115
 insects, III, 6
 leaf *Bucculatrix*, IV, 49
 remedies for, IV, 50
 Folder, The Lesser, IV, 47
 Skeletonizer, IV, 44, 47
 remedies for, IV, 45
 Tyler, IV, 46
 Maggot, III, 6, 9
 Maggot Fly, I, 108
 Micropteryx, III, 7
 Midge, III, 6
 Plant-louse, III, 6
 Root-lice, III, 95, IV, 68, 69
 Plant-louse, I, 118
 Artificial remedies for, I, 123
 Natural remedies for, I, 121
 Syrphus fly, I, 121
 tree Bark-louse, I, 7, III, 93
 borer, Flat-headed, I, 46, VII, 71
 Remedies for, I, 47
 Round-headed, I, 42, IV, 124
 VII, 27
 borer, Remedies for, I, 45
 Borers, I, 42

- Apple-tree Plant-louse, II, 6, 10
 Root-louse, II, 15, VI, 52
 Tent-caterpillar, II, 11, III, 117, 121
 twig Borer, IV, 51, V, 54
 Worm, I, 62, II, 6, 19, III, 6, 33, 90, 102,
 VII, 27
 Again, IV, 22
 Attacks peaches, V, 49
 False doctrines about, V, 51
 In California, V, 49
 Natural Enemies, V, 49
 Parasites, V, 49
 Remedies, I, 65
 Traps, V, 46
- apricans*, *Apion*, III, 11
apterus, *Micropus*, VII, 22
aquana (*Spilonota*), Supp., 37
Arachnida, V, 6, 7
archippivora, *Tachina*, III, 116, 150
Archippus, III, 168, 169, V, 148
 Butterfly, II, 125, III, 143
 How the larva becomes a chrysalis,
 III, 146
 It often congregates in immense
 swarms, III, 151
 Its natural history, III, 148
 The larva enjoys immunity from
 the attack of predaceous ani-
 mals, III, 148.
Tachina-fly, III, 150
- archippus*, *Danaus*, III, 143, 167, IV, 129, Supp., 55
areolata, *Hoplophora*, VI, 53, 81, VII, 106
Arctia Isabella, IV, 143, Supp., 55
Arctomys rufa, VI, 143
arcuata, *Ortalis*, II, 9
argillacea, *Aletia*, VIII, 23, Supp., 86
Argynnis, III, 103
diana, III, 169, 171
 Arkansas, Locusts in, IX, 76
Arma modesta, V, 123
spinosa, I, 77, 89, 113, II, 32, IV, 19, V, 51,
 Supp., 58
- armigera*, *Heliothis*, III, 45, 104, IV, 129
 Arment, A. B., on Rocky Mountain Locust, IX, 119
 Arnett, M. A., on Rocky Mountain Locust, IX, 117
 Arrhenotyky in the Imported Currant-worm, IX, 18
Arrhenodes septentrionis, VI, 116
 Arsenious acid for Potato-bugs, IV, 14
arthemis, *Limenitis*, III, 171
Arthropoda, V, 6
Articulata, V, 6
- Army Grasshopper, VII, 194
 Worm, I, 89, 109, II, 5, 37, 70, 103, 110, III,
 110, 125, 128, V, 22, 25, 68, VIII, 22, 182,
 IX, 49
 Additional Notes on Mode, Place, and
 Time of Oviposition, VIII, 182.
 Are there one or two Broods each year?
 VIII, 47
 Completion of its Natural History,
 VIII, 182
 Correspondents quoted, III, 109, VIII,
 39
 Description of the Egg, VIII, 34
 Larval Stages, VIII,
 184
 Fall Army-worm, VI, 17, VIII, 23, 35, 49
- Army Worm, Further Notes and Experiments on,
 IX, 47
 Habits of the Worm, VIII, 45
 Ichneumon Fly parasitic, on II, 53, 54
 Its History in 1875, VIII, 28
 Missouri in 1875, VIII,
 Its Sudden Appearance and Disap-
 pearance, II, 45, VIII, 50
 Microgaster parasite of, III, 156
 Natural Enemies, VIII, 53
 History, II, 47, VIII, 32
 Nomenclature, VIII, 22
 Northern, VIII, 24
 Parasites, II, 50
 Parent Moth, II, 11, 48
 Past History, II, 41, VIII, 24
 Plants Preferred by the, VIII, 49
 Remedies, VIII, 54
 Sexual Differences, VIII, 30
 Summary of Natural History, VIII, 56,
 IX, 49
Tachina-Fly parasitic on, IV, 109, VIII,
 53
 the term "Army Worm" applied to
 various Insects, VIII, 23
 time of Appearance, VIII, 46
 Wheat-head Army-worm, IX, 50
 When are the Eggs laid?, VIII, 40
 Where are the Eggs laid?, VIII, 38
- Army Worms, The three, II, 87
 Ashes and air-slacked lime for potato-bugs, IV
 14
 Ash-gray Blister-beetle, I, 97, 115
 Leaf-bug, II, 32, VII, 47
 Pinion, III, 134
- Asilus*-fly, II, 123, III, 161
Asilus missouriensis, II, 121, 122, IV, 21, V, 13,
 Supp., 87
sericeus, II, 123
- Asopia costalis*, VI, 102, 106
olinalis, VI, 103, 107
- asparagi*, *Oriocoris*, II, 10, 13, 19, VII, 5
Asparagus Beetle, II, 10, 13, VII, 6
Apidoglossa subangulata, I, 58
Apidiotus, I, 14
conchiformis, I, 7, II, 9, 10, V, 91, 94,
 Supp., 86
harrisii, I, 7, II, 9, Supp., 60
pinifolia, III, 92
- asterias*, *Papilio*, III, 169
Astoma, VI, 52
gryllaria, VII, 175, Supp., 63
parasiticum, VII, 176
- Astyci*, VIII, 176
- Atchison* (Kana.) *Champion*, article from, on
 Rocky Mountain Locust, VIII, 108
- atalanta*, *Pyrausta*, III, 167
atlantis, *Caloptenus*, VII, 169, VIII, 113, 114, 115,
 116, 117, 118, 153, Supp., 89
- Atlantic Locust, VIII, 150
 Atomiser for applying Paris green water, VI, 29
 VIII, 5
- atrata*, *Lytta*, I, 98, Supp., 54
atratus, *Tabanus*, II, 128, 129, 130
atricapillus, *Parus*, IV, 107, VI, 27
atriventris, *Lebia*, VIII, 3, Supp., 52
atrox, *Oedipoda*, VII, 124

- Attacus cecropia*, III, 129, 170, IV, 103, 138
cynthia, III, 170, IV, 112, 121, 138
luna, IV, 123, 138
mylitta, IV, 138
pernyi, IV, 137, 138
polyphemus, III, 170, IV, 110, 125, 138
promethea, IV, 110, 121, 138
selema, IV, 125
yama-mai, IV, 130, 138
- Aughey, Prof. Saml., on Rocky Mountain Locust, VIII, 114
- aurichalcea*, *Cassida*, II, 62, Supp., 53
Optocyclus, Supp., 53
- auricincta*, *Tachina*, V, 140
- auricapillus*, *Seiurus*, VI, 27
- Aurocoris*, a group of Heteroptera, V, 12
- autumnalis*, *Prodenia*, III, 13, 160, 116, IV, 129, VIII, 48
- avena*, *Aphis*, II, 5, 6, 10
- Avery, Wm. H., on Army Worm, VIII, 39
 Chinch Bug, VII, 44
 Rocky Mountain Locust, IX, 69
- Ayres, E. J., on Tarnished Plant-bug, II, 114
- B.**
- bacchus*, *Rhynchites*, III, 11
- Backbone animals, V, 6
- Bacon-beetle, VI, 100
- Bag-worm, I, 147, III, 160, IX, 17
 parasite, I, 150
- Bailey, S. S., on Army Worm, VIII, 39
- Balaninus*, III, 10
cerasorum, III, 11
nucum, III, 11
rectus, IV, 144
- Baltimore American*, article from, on Wheat-head Army-worm, IX, 51
- baltimore*, *Icterus*, VI, 27
- Baltimore Oriole destroying Canker Worm, VI, 27
 Katydid, VI, 162
 Pea-weevil, III, 50
- Banchus fugitivus*, IV, 41
- Bandage for Apple Worm, IV, 23
 Canker Worm, VI, 26, 27
- Banded Borer, III, 7
- barbara*, *Colaspis*, III, 82
- Barber, A. W., on White Pine-worm, IX, 30
- Barbicornis*, VIII, 170
basalis, VIII, 170
- Baridius sesostris*, III, 60, Supp., 71
trinotatus, I, 93, III, 60, Supp., 54
- Baris chlorizans*, III, 11
- Bark-beetles, III, 6
 -borer of hickory, V, 103
 -lice, II, 15, 25, III, 6, 10, V, 16, VI, 33
 classification of, V, 92
 of the Apple-tree, I, 7
 -louse, III, 85, V, 18
 on Apple, I, 7, V, 73
 remedies for, I, 16
 Currant, I, 15
 Pear, I, 15
 Persian lilac, I, 15
 Pine, V, 97
 Plum, I, 15
- Barker's Canker Worm trap, VIII, 21
- Barnet, W. N., on Phylloxera, VI, 82
- Barret, W. H., on Rocky Mountain Locust, VIII, 65
- Barron, W. H., on Rocky Mountain Locust, IX, 70
- Barter, A., on Grape-root Borer, I, 125
- Bartlett, Dr. L., on Army Worm, II, 49
- basalis*, *Micropus*, VII, 22
- basillare*, *Sinozydon*, IV, 52, 53, 54
- Basket-worm, I, 147
- Bassett, S. C., on Rocky Mountain Locust, IX, 117
- basiana*, *Botrytis*, IV, 88
- bastardi*, *Eraz*, II, 124
Promachus, II, 122, IV, 21, Supp., 60
- Bates, H. W., on Danaid Butterflies, III, 161
- Bat-ticks, V, 13
- Baxter, C., on Phylloxera, VI, 83
- Bazille, L., on Phylloxera in France, VII, 104
- Beach, H. P., on Locusts, VIII, 152
- Beal, M., on Chinch Bug, II, 17
- Bean-weevil, III, 45, 52, 54, 55
- Beautiful Wood Nymph, II, 83, 84, III, 64, VI, 88, 91, 95
- Bed Bug, II, 15, 31, V, 12
- Beech-twig Plant-louse, I, 121
- Bee-fly larva, Supp., 60
- Bee, Honey, IV, 84
- Bee-killer, I, 168, II, 121, IV, 21
 moth, I, 166, II, 10, III, 68
 parasite, V, 15
- Bees, V, 9
- Beetles, preparing of, for cabinet, V, 34
- Bell & Gruelle on Rocky Mountain Locust, IX, 92
- Belostoma grandis*, IX, 128
 probable eggs of, IX, 128
- Belt, J., on Rocky Mountain Locust, IX, 73
- Belvoisia bicincta*, V, 140
bifasciata, V, 140
- Bembex fasciata*, V, 9
- Beneficial insects, I, 169, III, 137, IV, 72, VI, 123
- Bennet, W. H., on Mimicry, III, 172
- Benson's machine for catching Potato-beetle, I, 117
- Berckmans, P. J., on Phylloxera, VII, 103, VIII, 164, 165
- berenicæ*, *Danais*, III, 143
- Bessey, Prof. C. E., on Colorado Potato-beetle, V, 54
 Common Flesh-fly, VII, 180
 Locust Mite, VII, 175
 Strawberry Worm, IX, 27
- bethunei*, *Xylina*, III, 186, Supp., 75
- betuleti*, *Rhynchites*, III, 11
- bicarinata*, *Polysephincta*, III, 71
- bicaudatus*, *Amphicerus*, IV, 51, V, 54
Bostrichus, III, 6, IV, 51, 53
- Bichromate of potash for Potato bug, IV, 14
- bicincta*, *Belvoisia*, V, 140
Senometopia, V, 140
- bicolor*, *Botys*, III, 61
- bifasciata*, *Belvoisia*, V, 140
Musca, V, 140
- bilineatus*, *Ophion*, III, 69
Telephorus, IV, 29, 30
- bipunctata*, *Xabea*, Supp., 61
- bipunctatus*, *Ecanthus*, Supp., 61
- Birds that destroy the Canker Worm, VI, 27, 28
- Birds vs. insects, III, 169, VI, 29

- Bismarck Tribune*, article from, on Rocky Mountain Locust, IX, 59
- distriga*, *Cryptoblabes*, IV, 46, Supp., 81
- Bi-sulphide of carbon for Phylloxera, VI, 56
- bivittata*, *Oasida*, II, 61, Supp., 53
- Saperda*, I, 42, II, 19, III, 6, VII, 27, Supp., 53
- bivittatus*, *Caloptenus*, VII, 124, 173
- Bivoltin Silkworms, IV, 85
- bivulnerus*, *Chilocorus*, I, 16, V, 100
- Black-bear caterpillar, The Large, IV, 141
- bellied Lebia, VIII, 3
- Blackberry fruit-worm, I, 139
- Blackbird destroying Katydid, VI, 162
- , Red-winged, destroying Chinch Bug, VII, 41
- Black Blister-beetle, I, 98
- Breeze-fly, II, 128, 129, 132
- larva of White-lined Morning Sphinx, III, 142, VIII, 122
- legged Tortoise-beetle, II, 63
- rat Blister-beetle, I, 98
- Stinger of the Oak, V, 126
- Blanchard, Stephen, on Rocky Mountain Locust, VII, 139
- Blatta orientalis*, II, 10
- Blepharida rhois*, I, 100, II, 58, VI, 118, 121
- Bliss, N. W., on Hickory Bark-borer, V, 103
- Blisus*, Supp., 58
- Blister-beetle, The Ash-gray, I, 97, 115
- Black, I, 98
- Black-rat, I, 98
- Brazen, III, 6
- Margined, I, 98
- Striped, I, 96, 115
- beetles, I, 115, Supp., 54
- remedies for, I, 99
- Blow-fly, II, 19, VII, 27
- Blue-bird destroying Canker Worm, VI, 27, 28
- Codling Moth, IV, 28
- Blue Caterpillars of the Vine, I, 136, II, 79, III, 63, 65, VI, 87
- Jay hiding corn in cocoons, IV, 107
- spangled Peach-worm, III, 132
- Stone for Potato-beetles, IV, 14
- Boardman, S. P., on Sheep Bot-fly, I, 164
- Bob-o-link destroying Canker Worm, VI, 27
- Bogus Chinch Bug, II, 31, V, 112, VII, 45
- Colorado Potato-beetle, I, 105
- Boissière, E. V., on Silkworm raising, IV, 82
- Boissière's silk establishment, IV, 82
- Boll-worm, III, 45, 104, 105, VI, 20
- remedies for, III, 108
- Bolteri*, *Eurytoma*, I, 177, Supp., 68
- Bombycidae*, IV, 85, V, 127
- Bombyx*, IV, 114
- graminis*, II, 44
- mori*, IV, 75, 84, 183
- Book-lice, V, 15
- Bordered Soldier-bug, I, 114, II, 34
- borealis*, *Epilachna*, IV, 18
- Borer, The Apple-twig, IV, 51, V, 54
- Flat-headed Apple-tree, I, 46, VII, 71
- Grape-root, III, 75
- Hickory Bark, V, 103
- Legged Maple, VI, 107
- Borer, The New Grape-root, I, 124, II, 87
- Peach, I, 47
- Potato Stalk, I, 92
- Raspberry Root, VI, 111
- Round-headed Apple-tree, I, 42
- Squash, II, 64
- Strawberry Crown, III, 42
- Yucca, VIII, 169, IX, 129
- Boston Daily Advertiser*, note from, on Army Worm, VIII, 29
- Boston Journal*, article from, on Canker Worm, II, 96
- Rocky Mountain Locust, III, 15
- Bostrichidae*, IV, 53
- Bostrichus*, IV, 53
- bicaudatus*, III, 6, IV, 51, 53
- botrana*, *Eudemia*, Supp., 57
- Lobesia*, Supp., 57
- Tortrix*, Supp., 57
- Botrytis bassiana*, IV, 88
- viticola*, VI, 36
- Bottom, R., on Rocky Mountain Locust, VIII, 62
- Botys bicolor*, III, 61
- bovinus*, *Tabanus*, II, 129
- Bowen, H., on destroying Potato-beetle, VI, 14
- Bowles, G. J., on imported Cabbage Butterfly, II, 107
- Box-turtle, IX, 98
- Boxes for insects, V, 37
- Brachinus*, Supp., 59
- kansanus*, IV, 21
- Brachista*, VI, 142
- Brachocera*, a division of Diptera, V, 13
- Brachypeplus magnus*, VIII, 148
- Brachypterus micropterus*, IX, 17
- Brachycolides*, V, 92
- Bracket, G. C., on remedies for Canker Worm, II, 100
- Strawberry Crown-borer, III, 42
- Tent-caterpillar of the Forest, III, 127
- Bracon charus*, VII, 75, Supp., 67
- scolytivorus*, V, 106, Supp., 67
- Braconides*, III, 27, V, 106
- polymorphi*, I, 96
- brassicæ*, *Anthonomyia*, I, 156, IV, 22, 35
- Aphis*, II, 10, IV, 36
- Pieris*, III, 167
- Plutia*, II, 110, 111
- Braula cæca*, V, 74
- Brazen Blister-beetle, III, 6
- Breast-bone in Cecidomyid larvæ, V, 114.
- Breck, Joseph, on remedies for Canker Worm, II, 100
- bradonii*, *Limenitis*, III, 171
- Breeding Insects, V, 41
- Breeze-fly, V, 13, VI, 123
- Brenthian, Northern, VI, 113
- Brenthus*, III, 10
- maxillosus*, VI, 116
- septentrionis*, VI, 116
- brevia*, *Phygadeuon*, IV, 28
- brevipennis*, *Eudryas*, VI, 91
- Brewer, F. A., on Phylloxera, V, 73
- Brimstone for Bark-lice, I, 17
- Briggs, A. A., on Flat-headed Borer, VII, 79

- Brünkerhoff, M., on Locusts, VIII, 154
 British America, Rocky Mountain Locust in, IX, 69
 Broadhead, G. C., on Pickle Worm, II, 69
 Rocky Mountain Locust, IX, 74
 Broad-necked Prionus II, 9, 87, 88, 89, V, 56
 -winged Katydid, V, 123, VI, 187
Brochymena annulata, IV, 20
 Brous, H. A., on Rocky Mountain Locust, IX, 66, 98, 99
 Brown Colaspis, III, 82
 Brown, A. M., on Apple Curculio, III, 34
 Brown, E. R., on Army Worm, VIII, 39
 Brown, L. A., on Army Worm, VIII, 39
 Brown, Major, on Colorado Potato-beetle, VII, 6
Bruchi, III, 51
Bruchides, III, 45
Bruchus albocutellatus, Supp., 71
 discoideus, III, 45
 erythrocerus, III, 55, 56, Supp., 70
 fabæ, III, 52, 55, Supp., 69, 70
 flavimanus, III, 56, Supp., 70
 granarius, II, 11, 14, III, 50, 51
 hibicus, Supp., 70, 71
 obsoletus, III, 54, 56, Supp., 70, 71
 pisi, II, 11, III, 44, IX, 43, Supp., 53
 piozum, Supp., 53, 71
 rustmanus, III, 56, Supp., 70
 serratus, III, 56, Supp., 70
 transversus, Supp., 70
 varicornis, III, 55, 56, Supp., 69, 70, 71
 Bruihl, Henry, on Army Worm, VIII, 39
 Bruner, Uriah, on Locusts, VII, 139
brunnea, *Colaspis*, III, 82
 Bryant, Arthur, on Hickory Bark-borer, V, 104
 Bryning, J. J., on Rocky Mountain Locust, IX, 69
bubalus, *Ceresa*, V, 12, 121
Bucculatrix pomifoliella, IV, 49, 51
 thuiella, IV, 51
 Buck-bug, V, 145
 Moth, V, 127
 Egg of, V, 128
 Issuing of, V, 132
 Larva of, V, 129
 Natural enemies of, V, 132
 Pupa of, V, 131
 Sting of larva of, V, 131
 Buffalo-gnat, V, 18
 Tree-hopper, V, 121
 Bugs, how to pin, V, 34
Buprestide, VII, 72
Buprestis gigantea, IV, 141
 Burns, A. M., on Locusts, VII, 138
 Burrows, J. H., on Rocky Mountain Locust, IX, 71
 Burt, Haron, on Codling Moth, III, 103
 Gooseberry Spanworm, IX, 5
 Plum Gouger, III, 40
 Tortoise-beetle, II, 57
 Bush & Son, list of grape-vine cuttings, showing relative ease of propagating, IV, 65
 Butcher-bird destroying Canker Worm, VI, 27
 Butterflies, classification of, V, 12
 preparing of, for cabinet, V, 35, 36
 pupation of, III, 148, IV, 55, VI, 138, VIII, 179, Supp., 55
 Two of our common, III, 142
 Butterflies, swarming of, III, 151
 Byfield, Jno., on Rocky Mountain Locust, VII, 152
 C.
 Cabbage-bug, the Harlequin, IV, 35
 Cabbage Butterflies, II, 111, V, 26
 Butterfly, the Potherb, II, 105
 Rape, II, 107
 Southern, II, 104
 caterpillar, the Zebra, II, 112
 -fly, IV, 35
 -maggot, V, 13
 Plant-louse, II, 10
 Plusia, II, 110, 112
 Tinea, II, 10, IV, 36
 Worms, II, 104, 123
 Remedies for, II, 109
 Cabinet and boxes for insects, V, 37
 Cabinet of insects prepared for Missouri State University, VII (preface, p. 5).
 Caddice-flies, V, 16
cagurus, *Polyzerus*, VII, 106
calidum, *Calosoma*, I, 89, 115, II, 103, VIII, 52
 California, Phylloxera ravages in, VIII, 163
 Silk growing in, IV, 79
californica, *Ecanthus*, Supp., 61
caliginosus, *Harpalus*, I, 115, VIII, 52
Callidium amoenum, IV, 54
Callimorpha clymene, III, 134
 fulvicosta, III, 132, 134, VI, 92, Supp., 56
 leontei, III, 134, VI, 92, Supp., 55
 vestalis, III, 133
Callidryas, III, 151
Callochloa viridis, III, 150
Callosamia angulifera, IV, 122, 128
 promethea, IV, 121, Supp., 55
calmariensis, *Galeruca*, II, 10, 95, VII, 5, 86
Calocampa exoleta, VIII, 23
calopteni, *Anthomyia*, IX, 92, 95, Supp., 89
Caloptenus allanii, VII, 169, VIII, 113, 114, 116, 117, 118, 153, IX, 86, Supp., 89
 bivittatus, VII, 124, 173
 differentialis, VII, 124, 171, 173, 180, VIII, 150, 153
 femor-rubrum, VII, 126, 128, 170, VIII, 114, 115, 116, 117, 118, 153, IX, 86, Supp., 89, 90
 italicus, VII, 133, VIII, 140
 occidentalis, VIII, 116
 spretus, VII, 121, 128, 138, 170, 180, VIII, 57, 109, 114, 115, 116, 117, 118, IX, 57, Supp., 89, 90
 viridis, VIII, 117
Calosoma, III, 129
 calidum, I, 89, 115, II, 46, 103, VIII, 52
 externum, VIII, 52
 obsoletum, IX, 98
 scrutator, II, 103, III, 129, VIII, 52
 vilcozi, VIII, 52
 Cambre, Eugene, on preventing Phylloxera, VII, 113
 Camel-cricket, I, 169, III, 68
 Campbell, G. W., on Grape Phylloxera, VII, 100
 Campbell, W. A., on Rocky Mountain Locust, IX, 73

- Campoplex fugitivus*, I, 139
Campyloneura vitripennis, III, 137
Canada Warbler destroying Canker Worm, VI, 27
Canadian Entomologist, article from, on Hellebore for Currant Worm, IX, 14
Canaday, Elihu, on Army Worm, VIII, 40
canadensis, *Myiodictes*, VI, 27
candida, *Saperda*, Supp., 53
Cane Curculio of the Grape, I, 131
canticuli, *Cuterebra*, I, 164
Canker worms, I, 9, 109, II, 11, 15, 54, 94, 95, 99, 101, 103, III, 128, 160, IV, 23, 40, VI, 24, VII, 80, VIII, 12, Supp., 56
Bandages for, VI, 26, 27
Birds that devour the worms, VI, 27, 28
Destroyed by plowing, II, 100
Distinction between two species of, VI, 27
Enemies of, II, 102
Extract from the original Essay on, by W. D. Peck, VII, 89
Fall canker-worm, VII, 83, VIII, 18
Oviposition of the two different species, VIII, 87
Origin of, II, 96
Paris green for, VI, 26
Practical considerations, VII, 85
Remedies against, II, 98, VI, 26, VIII, 17, 20
Spring canker-worm, VII, 80, VIII, 18
Traps, VI, 26, VIII, 20, 21
Trough remedy for, VI, 26
Two species defined, VIII, 13
Cantharides, V, 18
capax, *Xylina*, III, 136, Supp., 75
Caper, Dr., on Cotton Worm, II, 38
Capsus oblineatus, II, 113, VII, 27
vitripennis, III, 139
Carabidae, VI, 123
Carabid larvae, I, 59, IX, 97, Supp., 52
Carbolate of lime for Potato bugs, IV, 14
Carbolic acid for Grape-vine Root-lice, IV, 68
cardui, *Oynthia*, III, 151, IV, 129
Pterophorus, Supp., 63
carduidactylus, *Pterophorus*, I, 180, III, 67
Carie, VI, 52
caritaria, *Sarcophaga*, VII, 180, IX, 93, Supp., 60
Carolina Locust, VII, 179, IX, 92
carolina, *Mantis*, I, 169, III, 68
Cedipoda, VII, 175, 179
Sphinx, I, 96, IV, 129
carolinensis, *Mimus*, VI, 27, VIII, 124
Carpenter, D., on Rocky Mountain Locust, VIII, 102, IX, 70
Carpenter Moth, II, 10
Carpocapsa, V, 50
pomonella, I, 62, 108, II, 10, III, 6, 101, IV, 27, V, 154
vitisella, I, 183
Carr, Wm., on Army Worm, VIII, 39
Carrier-beetle, American, VI, 100
-feeders, V, 11
Carson, J., on Rocky Mountain Locust, IX, 75
caryæ, *Scolytus*, V, 103, 107, Supp., 54
caryæcaulis, *Phyllozera*, VII, 91, 97, 99, 117
caryæ-fallax, *Phyllozera*, VII, 118
caryæ-folios, *Phyllozera*, IV, 66, VI, 45, VII, 117
caryæ-globuli, *Phyllozera*, VII, 117
caryæ-gummosa, *Phyllozera*, VII, 118
-*ren*, *Phyllozera*, VII, 118
-*semen*, *Phyllozera*, VII, 117
-*septa*, *Phyllozera*, VII, 118
caryævenæ, *Phyllozera*, VII, 117
Case-bearer, Walnut, IV, 42
-bearing *Coleoptera*, VI, 127, 128
cassi, *Piophila*, II, 10
Caskie, Robt. E., on Army Worm, VIII, 39
Cass County (Mo.) *Courier*, article from, on Rocky Mountain Locust, VIII, 65
Cassida, I, 100, II, 58, 59
aurichalcea, II, 62, Supp., 53
bivittata, II, 61, Supp., 53
cruciata, II, 63
guttata, II, 60, 63
nigripes, II, 63, Supp., 53
pallida, II, 62, Supp., 53
signifer, II, 63
texana, Supp., 54
trabeata, II, 63
cassini, *Cicada*, I, 20, 21, IV, 33, Supp., 50
castanea, *Phyllozera*, VII, 118
Castnia *licus*, VIII, 178
linus, VIII, 178
yuccæ, VIII, 173
Castnioides, a proposed tribe of butterflies, VIII, 179
Castor-bean Silkworm, IV, 112
Cat Bird destroying Rocky Mountain Locust, VIII, 124
destroying Canker Worm, VI, 27
Caterpillars of the Vine—The blue, VI, 87
Catocala, VIII, 178
phalanga, III, 166
Cecidomyia, Supp., 59
destructor, II, 10, 19, V, 25, VII, 27
Cecidomyiidae, larval characters of, V, 114
cecropia, *Attacus*, III, 129, 170, IV, 74, 103, 138
Hyalophora, IV, 103
Platysamia, IV, 103
Samia, IV, 103, Supp., 55
Cecropia *Cryptus*, IV, 110
Silkworm, IV, 103
Food-plants, 104
Larval Changes, IV, 106
Parasites of, IV, 107
Tachina-fly, IV, 108
worm, III, 7
cecropiæ, *Exorista*, IV, 108, Supp., 60
Cedar-bird destroying Canker Worm, VI, 27
cedrorum, *Ampelis*, VI, 27
Celæna, I, 68
egens, Supp., 56
herbimacula, I, 66
infecta, Supp., 56
murcimaculata, Supp., 56
oblonga, III, 136, Supp., 75
renigera, I, 66, Supp., 56
subcadens, Supp., 56
celtis, *Apatura*, VI, 139, 142
Ceutorhynchus napsi, III, 11
ceparum, *Anthomyia*, I, 155, II, 9
cerasi, *Selandria*, II, 19, VII, 27
Cerasphorus cinctus, III, 7, VII, 76
Ceratocampinae, V, 127

Ceratopogon, Supp., 59
cereana, *Galleria*, I, 166, II, 10, Supp., 57
Ceresa bubalus, V, 12, 121
Ceretes, VIII, 178
Certhiadae, IV, 28
cervicalis, *Scymnus*, I, 122
Chærocampa, II, 71
 pampinatrix, II, 71
Chalcididae, V, 88
Chalcis, II, 92, III, 158
 albifrons, II, 52, VIII, 54
 maria, IV, 109, 110, 123
Chalcis-fly, II, 52, IV, 51, V, 89
 The inflating, I, 176
chalybea, *Haltica*, I, 101, III, 79, 81, Supp., 53
Chambers, V. T., on Cicada, I, 20, 28
Change of habit, III, 91
Chapin, Oliver, on Codling Moth, IV, 26
charus, *Bracon*, VII, 75, Supp., 75
Chatterer of Carolina destroying Canker Worm, VII, 90
Chauliognathus, IV, 30
 americanus, Supp., 53
 marginatus, V, 154
 pennsylvanicus, I, 57, IV, 28, V, 154, Supp., 53
Cheese Fly, II, 19, VII, 27
 Maggot, II, 10
Ohelymorpha, II, 58, 59
 cribraria, II, 58
chenopodii, *Hadena*, Supp., 76, 77
Cherished Bracon, VII, 75
Chermes pinicorticis, V, 100
Cherry-bird destroying Canker Worm, VII, 90.
Chestnut-sided Warbler destroying Canker Worm, VI, 27.
Chickadee storing corn in cocoons, IV, 107
 destroying Canker Worm, VI, 27
Chickweed Geometer, I, 179. [See Knotweed]
Chicago Times, article from, on Rocky Mountain Locust, VIII, 73
Chicago Tribune, articles from, on Rocky Mountain Locust, VII, 155, VIII, 82, 107
Child, A. J., on Rocky Mountain Locust, VIII, 91
Ohilocorus bivulnerus, I, 16, V, 100
Chinch Bug, II, 2, 6, 11, 15, 16, 19, 20, 32, 33, 70, 114, V, 12, 19, 62, VII, 19, 190, VIII, 22, 120, 142, 143
 Abstaining from the cultivation of the grains upon which the insect feeds, VII, 38
 Amount of damage done by, II, 28
 Appearance and transformations of, VII, 20
 Appendix to the article on, VII, 51
 Bogus Chinch Bug, II, 31, V, 112
 Burning as remedy for, VII, 32
 Cannibal foes of, II, 23
 Destructive powers of, II, 22, VII, 24
 Direct remedies against, VII, 31
 False Chinch Bug, V, 111
 Flight of, VII, 29
 Food plants, VII, 26
 Heavy rains destructive to, II, 24, VII, 30
 Importance of winter work and combined action, VII, 36
 Injurious to stock, VII, 43
 Injuries in Missouri in 1874, VII, 25

Chinch Bug—Continued.

Injuries in 1874, VII, 24
Invigorating the plant by manure, early sowing, etc., VII, 34
List of correspondents who made returns, VII, 51
Migration on foot, VII, 30
Mixing seed or protecting one plant by another, VII, 34
Mode of reproduction and hibernation, VII, 27
Natural enemies, VII, 38
Natural history, II, 18
Past history, II, 17, VII, 22
 in Missouri, VII, 22
Possible remedial and preventive measures that need further and thorough trial, VII, 41
Preventing the migration of, from one field to another, VII, 35
Preventive measures, VII, 32
Prognosticating, VII, 24
Questions answered by correspondents, VII, 52
Recapitulation of its natural history, II, 36, VII, 49
Remedies against, II, 28
Rolling as preventive, VII, 33
Unnecessary fears, VII, 44
Where the eggs are laid, VII, 28
Chipping Sparrow destroying Canker Worm, VI, 27
Ohlamys, III, 159
 plicata, VI, 128, 130
chlorizans, *Baris*, III, 11
Chlorops, I, 160
Chronological history of Periodical Cicada, I, 30
Ohrysobothris femorata, I, 46, III, 6, VII, 71, Supp., 67
 var. *alabama*, VII, 71
 fastidiosa, VII, 71
 lesueuri, VII, 71
 misella, VII, 71
 obscura, VII, 71
 4-impressa, VII, 71
 semisculpta, VII, 71
 soror, VII, 71
Ohrysomela, II, 57, 59, III, 45, VII, 18
 decem-lineata, VII, 16, 18
 meticulosa, VI, 122
 rhois, VI, 122
 stolida, VI, 122
Ohrysomelidae, III, 14
Ohrysopa, I, 57, III, 150, IV, 45
 eriosomatia, I, 123
 Illinoiensis, II, 26, VII, 39, 40
 plorabunda, II, 26, VI, 51, VII, 40
 tabida, VII, 106
Ohrysops vittatus, II, 129
Oicada, VI, 37, VIII, 38
 cassinii, I, 20, 21, IV, 33, Supp., 59
 pruinosa, I, 27
 septemdecim, I, 18, 19, 20, II, 19, III, 6, IV, 31, VII, 27, Supp., 58, 59
 tridecim, I, 19, II, 19, III, 6, VII, 27, Supp., 58, 59
Cicada, The Periodical, I, 18, IV, 30

- Otocada*, II, 131
Cicindela circumpecta, IX, 98
 formosa, IX, 98
 fulgida, IX, 98
 punctulata, IX, 98
 pulehra, IX, 98
 repanda, VIII, 52
 scutellaris, IX, 98
 seziguttata, IX, 98
 vulgaris, IX, 98
Cincinnati Gazette, article from, on Rocky Mountain Locust, IX, 84
cinctus, *Cerasphorus*, III, 7, VII, 76
 Harpactor, I, 114, VII, 41, Supp., 58
 Tabanus, II, 129
cinderella, *Tortriz*, IV, 47, Supp., 82
cinerea, *Epicauta*, Supp., 54
 Lytta, I, 97, Supp., 54
 Pisma, II, 32, VII, 47
 Xylina, III, 134, 135, Supp., 75
cinereopunctella, *Elachista*, VI, 138
cinerosa, *Xylina*, III, 136, Supp., 75
cingulatus, *Oncideres*, III, 6
circumcinctus, *Perillus*, IV, 19
Citheronia regalis, III, 151, IV, 129, V, 141
clandestina, *Noctua*, I, 79, Supp., 55
Clandestine Owllet-moth, I, 79
Clark, Rufus, Machine for destroying Locusts, VIII, 129
Clark, William H., on Rocky Mountain Locust, IX, 74
Classification of insects, V, 8
Classification, remarks on, I, 98, 99, II, 71, III, 94, 95, 96, 133, 143, IV, 46, V, 9, VII, 143, 170, VIII, 170, 178, 179
clavata, *Deloyala*, II, 57, Supp., 54
Claxton & Stevens, Curculio Catcher of, III, 22
Cleveland, J. L., on Rocky Mountain Locust, IX, 73
Clemens, Dr. B., description by, of *Callimorpha fulvicosta*, III, 133
Cleonymus clisiocampæ, III, 120
Olerus apiarus, VI, 101
Cleveland Herald, article from, on Grape-vines, V, 58
Climbing cut-worms, I, 76
Otiocampa americana, II, 7, III, 117, V, 56
 diastria, Supp., 55
 sylvatica, II, 7, 37, III, 121, IV, 41, Supp., 55
clisiocampæ, *Cleonymus*, III, 120
 Semiotellus, III, 120
Clostera americana, II, 19, VII, 27
Clothes Moth, II, 10
Clover-hay Worm, VI, 102
 Natural History, VI, 105
 Remedies, VI, 105
Clover Worms, VI, 103
 in the State of New York, VI, 104
Clubbed Tortoise-beetle, II, 56, 57
Clumsy Locust, VIII, 148
clymene, *Callimorpha*, III, 134
Clythra, VI, 128, 130
clyton, *Apatura*, VI, 142, 145
Clytus pictus, III, 7, VI, 101
Cnethocampa processionea, V, 126
enotus, *Otus*, II, 71
Ooball, for Potato-beetle, IV, 14
Oocidæ, II, 15, V, 16, 92, VI, 33
Oocinella, VI, 51
 munda, II, 25, VII, 39, Supp., 52
 nocennotata, I, 112
 picta, V, 101, Supp., 52
Oocinellidæ, V, 11, 27
Oocotorus, Supp., 54
Coccus adonidium, III, 96, V, 80
 cacti, V, 18
 lacca, V, 18
Oocyzus americanus, III, 121
 erythrophthalmus, III, 121, VI, 27
Cochineal, IV, 84, V, 18
Oochytis hilarana, I, 175, II, 135
cochranti, *Agrotis*, I, 74, Supp., 76, 77
Cochran, J. W., on Dark-sided Cut-worm, I, 75
 on Climbing cut-worms, I, 60
Cochran Rustic, I, 74
Cocklebur Spheonophorus, III, 60
Cockroach, II, 10, V, 14
Cocoon, issuing of moth from, IV, 105, 127
Codling Moth, I, 62, II, 6, 10, III, 32, 101, 118, IV, 22, 27, 48, V, 26, 47, VI, 9
 Again, IV, 22
 Attacks peaches, IV, 22, V, 49
 Best kind of bandage for, IV, 23
 False doctrines about, V, 51
 Fires, lights, bottles of liquid as remedies, IV, 27
 Found in California, V, 49
 Jarring as remedy, IV, 25, V, 48
 Natural enemies of, IV, 28, V, 49
 New methods of trapping, IV, 23
 Remedies for, I, 65, IV, 25, V, 48
 Sweetened water as remedy for, IV, 138
 Time of year that the first moths appear, IV, 22
 Wier's Trap, IV, 23, V, 47, VI, 10
Celiodes inæqualis, I, 128, III, 60, Supp., 54
Colaspis barbara, III, 82
 brunnea, III, 82
 flavida, III, 44, 63, 81, 84, IV, 84, V, 108
 suilla, III, 82
Colby, Lewis, on Locust ravages, VII, 168
Cole, M., on Phylloxera, VIII, 166
Coleoptera, classification of, V, 10
 preparing of, for cabinet, V, 84
Collecting insects, V, 29
Colman's Rural World, article from, on Phylloxera, VI, 83, 84
Colorado Farmer, article from, on Rocky Mountain Locust, VIII, 84, 156, IX, 62
Colorado Locust, VII, 188
Colorado Potato-beetle, I, 101, 102, II, 6, 19, 25, 32, 59, III, 80, 96, IV, 5, V, 26, 52, 62, VI, 11, 17, 18, VII, 1, 29, 39, VIII, 1, 137, IX, 17, 34
Alarm about it abroad, VII, 3
Amount of damage caused by it in Missouri, IV, 7
An addition to its natural enemies, IX, 40
Area invaded by, IX, 38
Arsenious acid as remedy, IV, 14
Artificial remedies for, I, 116
Best means of fighting it, III, 97
Bichromate of potash as remedy, IV, 14

Colorado Potato-beetle—Continued.

- Bogus experiments, III, 100
 Carbolate of lime as remedy, IV, 14
 Causes which limit the spread of, IX, 38
 Dog-fennel as remedy, IV, 15
 Damage during the year 1875, VIII, 1
 Enemies of, I, 111, 112, 113, 114, 115, IV, 16, V, 52, VIII, 3, IX, 40
 Further experience with Paris green, VIII, 5
 Gray's Improved Sprinkler, VII, 15
 Hellebore as remedy, IV, 14
 How it affected the price of potatoes, IX, 39
 How it traveled, IX, 37
 Is it poisonous? VII, 6
 It passes the winter in the beetle state, VII, 14
 It reaches the Atlantic, VII, 1
 It spreads, but does not travel in the sense of leaving one district for another, IV, 9
 Its habits, I, 107
 Its hibernation, IV, 11
 Its injuries in 1871, IV, 5
 Its introduction to Europe, IX, 43
 Its past history and future progress, I, 161
 Its progress eastward, V, 52, VI, 12
 Its scientific name, VIII, 2
 Machine for sweeping it off vines, VIII, 4
 Mandrake or May-apple as remedy, IV, 15
 Mechanical means of destroying, IV, 15, VI, 14
 Modification it has undergone in habits, IX, 40
 Native home of, VIII, 8
 Natural checks increasing, III, 100
 Natural remedies, I, 109
 New food plants of, IV, 10, V, 52, VI, 11, VII, 14
 New means of destruction, VII, 15
 New territory invaded, IV, 8
 Occurrence in the Atlantic States, VIII, 1
 Parasite of, I, 111
 Paris green as remedy, III, 99, IV, 11, V, 52, VI, 16, VII, 8, VIII, 3
 Peck's Spray Machine, VIII, 4
 Placard published by the German Government, IX, 44
 Poisonous qualities of, VIII, 11
 Potato Pest Poison as remedy, IX, 45
 Powdered Hellebore as remedy, IV, 14
 Preparing for it in Europe, VI, 15
 Rate at which it traveled, IX, 37
 Remedies for, I, 109, 116, III, 99, IV, 11, 13, 14, 15, V, 52, VI, 13, VII, 3, 7, 8, VIII, 3, IX, 45
 Spread of the insect during the year 1876, IX, 34
 Sulphate of copper as remedy, IV, 14
 The beetle eats as well as the larva, VII, 14
 The Bogus Colorado potato-beetle, I, 105
 The proper scientific name of the beetle, VII, 16
 The true remedy, III, 101
 Use of straw as a preventive, VIII, 4
 Colorado Potato Bug (see Colorado Potato-beetle).
 Colorado, Rocky Mountain Locust in, VIII, 84, IX, 62
columbia, *Samia*, IV, 107, 111, 123, Supp., 55
comma, *Leucania*, VIII, 43
commelineæ, *Prodenia*, I, 88, III, 13, Supp., 56
 Commission, National Entomological VIII, 133
 Common Currant Plant-louse, IX, 2
 Flesh-fly, VII, 180, IX, 85
 May Beetle, III, 8

- Common Pruner, III, 6
 Quail destroying Chinoh Bug, II, 28
 Yellow Bear, III, 67
communis, *Melanotus*, III, 6
compta, *Oeta*, I, 151, Supp., 58
Paciloptera, I, 152
comptana, *Anchylopera*, I, 143
Phoxopteris, Supp., 57
conceavum, *Platyphyllum*, V, 124, VI, 167
conchiformis, *Aspidiotus*, I, 7, II, 9, 10, III, 93, Supp., 86
Conchyitis ambiguella, Supp., 57
 Cone-like willow-gall, VI, 155
conformis, *Xylina*, III, 136, Supp., 75
conica, *Phyllozera*, VII, 118
conicus, *Rhynchites*, III, 11
Conocephalus, VI, 155
conotracheli, *Porizon*, III, 28, Supp., 64
Conotrachelus, V, 154
cratagi, III, 35, 39
juglandis, Supp., 54
nenuphar, I, 50, III, 11, 23, 127, Supp., 54, 65, 68
conquisitor, *Pimpla*, IV, 43
consociella, *Acrobasis*, IV, 45
conspersa, *Amphipyra*, III, 75, Supp., 75
 Consumptive Lace-wing, VII, 106
Contopus virens, VI, 27
contracta, *Meracantha*, VI, 118
contractilis, *Hoplophora*, VI, 54
convergens, *Hippodamia*, I, 112
 Convergent Lady-bird, I, 112
convolutella, *Myelois*, Supp., 57
Zophodia, Supp., 57
 Copper, sulphate of, for Potato-beetle, IV, 14
Coptocycla, II, 58, 59, 63, Supp., 53, 54
aurichalcea, Supp., 53
guttata, Supp., 53
 Coral-winged Locust, VIII, 104
Coreus linearis, II, 113
tristis, I, 113, II, 31, VII, 46, Supp., 58
Corimelæna lateralis, II, 35
pulicaria, II, 33, VII, 48
unicolor, II, 35
 Cornaby, Samuel, on Silkworms, IV, 101
 Corn Anthomyia, I, 155
 Cut-worm, I, 87
 Maggot, I, 154
 Rustic, I, 81
 Sphenophorus, III, 59
 Worm, III, 45, 104, 105, 111
cornutus, *Corydalis*, V, 143, IX, 125, Supp., 63
Pasalus, IV, 139, 140
Corypodacus purpureus, VI, 27
Corydalis cornutus, V, 143, IX, 125, Supp., 63
Corynetes rufipes, VI, 96, 101
violaceus, VI, 101
Coscinoptera dominicana, VI, 127
Cossus, VIII, 177
costalis, *Asopia*, VI, 102
Tabanus, II, 128
Cotalpa lanigera, V, 10
 Cotton Army-worm, II, 41, VIII, 23
 Boll-worm, III, 111
 moth, II, 40
 Position of when alighting, VI, 24

- Cotton Worm, II, 38, III, 105, V, 19, 68, VI, 17, VII, 9
 Hibernation of, VI, 22
 Natural enemies of, VI, 23
 Paris green as remedy, VI, 20
 Range of, VI, 23
 worms, II, 37
- Cottonwood Dagger, II, 119
 Gall plant-louse, I, 120
- Country Gentleman, article from, on Apple Worm
 remedy, V, 48
 article from, on Clover Worm,
 VI, 104
 article from, on Curculio, IV,
 26
 article from, on Grape-vine
 Colaspis, III, 82
 article from, on Locusts, VII,
 172, VIII, 152
 article from, on Phylloxera,
 V, 59, VI, 82
 article from, on Potato-beetle,
 I, 111
 article from, on Tent-caterpil-
 lar, III, 125
- County reports (Mo.) on Rocky Mountain Locust,
 IX, 68
- Crabro stirpicola*, IX, 95, Supp., 89
crabro, *Vespa*, IV, 22
 Cranberry-weevil, III, 60
 Crandall, O. A., on Rocky Mountain Locust, IX, 74
 Crane-flies, I, 180, II, 132
crantor, *Phobus*, II, 74
Sphinx, II, 74
Oraponius, Supp., 54
cratagi, *Conotrachelus*, III, 35, 39
Oratoparis lunatus, III, 10
 Cream Callimorpha, III, 133
 Creepers destroying Codling Moth, IV, 28
 Black and White, destroying Canker
 Worms, VI, 27
- Creighton, Samuel, Insect-destroyer invented by,
 IV, 15
- cressonit*, *Hemiteles*, I, 177, Supp., 65
- Craig, Wm. G. M., on Rocky Mountain Locust, IX,
 73
- cribraria*, *Chelymorpha*, II, 58
 Crickets (*Gryllidae*), V, 14, VI, 154
erinitus, *Myiarchus*, VIII, 124
Oriocera asparagi, II, 10, 13, 19, VII, 5
merdigera, II, 58
- Croton Bug, II, 10
- Crow destroying Katydid, VI, 162
 Potato-beetles, VIII, 3
- Crow, J. H., on Rocky Mountain Locust, IX, 72
- Crow Blackbird destroying Canker Worms, VI, 27
 Codling Moths, IV, 28
 Locusts, VIII, 124
 Pea-weevils, III, 50
- Crown-borer of the Strawberry, III, 44, 83
cruciata, *Ossida*, II, 63
cruciferarum, *Plutella*, II, 10, IV, 36
- Crustacea, a class of Segmented animals, V, 6, 7
- Cryptoblabes bistrica*, IV, 46, Supp., 87
- Cryptoccephalus*, VI, 128, 130
- Cryptus extrematis*, IV, 110, 111, 123, Supp., 52
grallator, VII, 75
inquisitor, I, 150
- Cryptus nuncius*, IV, 110, 111, 123, Supp., 52
samias, IV, 110, 111, Supp., 52
smithii, IV, 111
- Ctenucha americana*, II, 85
- Cuckoo, Yellow-billed, destroying Canker Worm,
 VI, 27
 Locusts, VIII,
 124
- Cucumber-beetle, I, 100, II, 62, 65
 flea-beetle, I, 101, II, 57, V, 112
cucumeris, *Halitica*, I, 101, II, 57, Supp., 53
cunea, *Hyphantria*, Supp., 55
- Curculio, II, 11, 16, 92, III, 13, 16, 25, 29, V, 22
 Apple, III, 29
 Natural history of, III, 30
 Remedies for, III, 34
- Catcher, Hooten's, III, 23
- Hull's, III, 19, V, 25
 Ward's, III, 20
- Grape, I, 128, III, 60
- Grape-cane Gall, I, 131
- Grape-seed, I, 129
- Plum, I, 50, III, 11
 Enemies of, I, 57
 Parasites of, III, 24
 Points in its natural history, I, 50, III,
 11
 Remedies for, I, 60, III, 15
- Quince, III, 35
- Curculionidae*, characteristics of, III, 9
 creaking noise produced by, III, 14
- curculionis*, *Sigalphus*, III, 25, 27, Supp., 67
- cucurbitae*, *Ageria*, II, 64
- Currant Aphid, VI, 46
 Fruit-worm, I, 140
 Plant-louse, II, 10
 -stem Borer, VI, 108
- Currant Worm, II, 8, 9, 96, IV, 14, IX, 1
 the imported, IX, 7
 the native, IX, 23
 fly, IX, 19
- Cursoria, a section of Orthoptera, V, 14
cursoria, *Agrotis*, I, 78
- curvicauda*, *Phaneroptera*, VI, 164
- Curvirostra leucoptera*, VI, 27
- Cuterebra*, III, 150
caniculi, I, 164
- Cut-worm lion, I, 90
 The climbing, I, 69, 76
 The Dark-sided, I, 74
 The Dinky, I, 82
 The Glassy, I, 83
 The Greasy, I, 80
 The small White Bristly, I, 86
 The Speckled, I, 84
 The Variegated, I, 72
 The Western Striped, I, 81
 The Wheat, I, 87
 The W-marked, I, 79
- Cut-worms, I, 67, II, 16, 45, III, 6
 Natural history of twelve distinct species, I, 67
 Remedies against, I, 89, 90
- cyanea*, *Cyanopiza*, VI, 27
- Cyanopiza cyanea*, VI, 27
- Cycloneda sanguinea*, Supp., 52
- Cylindrical Orthosoma, I, 126, II, 91
- cylindricum*, *Orthosoma*, I, 124, II, 87

- Oyllene pictus*, VI, 101
Oyllocoris scutellatus, V, 154
 Cynipidæ, VI, 70
Cynips, II, 135
 galle-tinctoriæ, V, 18
 quercus-aciculata, Supp., 59
 quercus-inanis, I, 14
 quercus-spongifica, I, 14
cynosbana, (*Spilonota*), Supp., 57
cynthia, *Attaeus*, III, 170, IV, 74, 112, 138
 Samia, IV, 112
Cynthia cardui, III, 151, IV, 129
Cyrtophyllus, V, 123
- D.**
- Dactylopius longispinus*, IV, 70, VI, 63
Dactylophæra, III, 93, 94
 caryæ-magnum, VII, 117
 caryæ-semen, VII, 117
 caryæ-septum, VII, 117
 conicum, VII, 118
 coniferum, VII, 118
 depressum, VII, 118
 forcatum, VII, 118
 globosum, VII, 117
 hemisphericum, VII, 117
 spinosum, VII, 118
 subellipticum, VII, 117
 vitifolice, I, 13
Dactylophæridæ, III, 85, VI, 31
Dade County Advocate, article from, on Rocky Mountain Locust, VIII, 68
 Daggy, E., on False Army-worm, III, 112
 on Apple Curculio, III, 33
 Dakota, Rocky Mountain Locust in, VIII, 85, IX, 59
Dakrura turbatella, Supp., 57
Danaë, II, 125, III, 161, 163, 169, V, 146
 arehippus, III, 143, 167, IV, 129, V, 149, Supp., 55
 berenice, III, 143
 erippus, III, 143
Daphne pandorus, II, 76
Darapsa myron, II, 71
 Dark-sided Cut-worm, I, 74
 tipped *Anomalon*, IX, 55
 Dart-bearing Rustic, I, 82
 Darwin, Charles, on Evolution, III, 172, 173
 Darwinism, argument in favor of, III, 173
Datana ministra, III, 124, 127, 129, IV, 129
 Davis, C. K., on Rocky Mountain Locust, VII, 154
 Dawson, G. M., on Rocky Mountain Locust, VII, 155, IX, 78
 Dean, J. J., on Colorado Potato-beetle, VIII, 2
deceimlineata, *Chrysomela*, VII, 18
 Doryphora, I, 101, 103, IV, 8, VI, 12, 18, VII, 1, 16, 18
 Deer Fly, V, 127
 Defakough, David, report on Rocky Mountain Locust, IX, 70
 Definition of Entomology, V, 5
 Defunctionation of special parts in the imported Currant Worm, IX, 19
Deilephila lineata, III, 140
Deiopeia bella, V, 11
 Delicate Long-ating, V, 50
- Deloyala*, II, 59
 clavata, II, 57, Supp., 54
Dendroica æstiva, VI, 27
 discolor, VI, 27
 maculosa, VI, 27
 pennsylvanica, VI, 27
 striata, VI, 27
 Department of Agriculture, inefficiency of, VII (p. preface, p. 5).
depressa, *Phylloxera*, VII, 118
Dermaleichus, V, 87
Dermestes, IV, 97, V, 41
 lardarius, VI, 100
Desmia maculalis, III, 61
 Descriptive entomology, comments on, III, 123
 Destination of departing Locusts, VIII, 107
 Detention in Missouri from Locust injuries, VIII, 91
 Destructive powers of the Chinch Bug, II, 22
destructor, *Cecidomyia*, II, 10, 19, VII, 27
 Nysius, VII, 190, Supp., 84, 85
 Devastating Dart, I, 83
devastator, *Agrotis*, I, 83, Supp., 56
 Devil's Riding-horse, I, 169
Diabrotica vittata, I, 100, II, 62, 64, III, 6
 12-punctata, II, 66
diadema, *Sinea*, Supp., 58
diana, *Argynnis*, III, 69, 171
 Diaspidæ, a subfamily of *Oecidæ*, V, 92
Diaspis, V, 91, Supp., 60
 ostreaformis, Supp., 60
diastrophæ, *Eurytoma*, Supp., 68
 Dictyoptera, a division of Neuroptera, V, 14
 Differential Locust, VII, 124, 173, VIII, 150, 153
 eggs of, VIII, 154
differentialis, *Caloptenus*, VII, 124, 173
 Digger Wasp, II, 106, III, 8, VII, 174
dilatatus, *Velleius*, IV, 22
 Dimera, a division of Homoptera, V, 13
dimidiatus, *Micropus*, VII, 22
 Diminished *Pezomachus*, II, 52, VIII, 54
 Dimorphism in butterflies, III, 165
 locusts, VIII, 115
 Prionus, II, 90
Dinarda, IV, 22
 Dingy Cut-worm, I, 82
Diplosis tritici, II, 10
 Diptera, classification of, V, 13
discoideus, *Bruchus*, III, 45
discolor, *Dendroica*, VI, 27
 Diseases of Mulberry Silk-worm, IV, 87
 Disippus Butterfly, II, 125, III, 153, 168, 169
 Description of mature larva, III, 154
 Description of the egg, III, 154
 Parasites of, III, 157
 Winter quarters of, III, 155
 Microgaster, III, 158
disippus, *Limenitis*, III, 153, 163, 169, 171, Supp., 66
 Nymphalis, II, 125
dispar, *Hypogymna*, II, 10
disetria, *Olisiocampa*, Supp., 55
distinctus, *Passalus*, IV, 141
 Dixon, F. M., on Army Worm, VIII, 39
 Dodge, C. R., on Rocky Mountain Locust, VII, 164, VIII, 173
Dolichonyx oryzivorus, VI, 27, VIII, 52

- domestica*, *Musca*, II, 10
Domestication of insects, IV, 85
dominicana, *Coscinoptera*, VI, 127
Dominican Case-bearer, VI, 127
Dopf, J. D., on Canker Worms, II, 98
 on Rocky Mountain Locust, IX, 68
Dorr, R. L., on Grape-vine Tomato-gall, V, 118
dorsatum, *Phalangium*, IV, 17
Doryphora concatenata, VIII, 2
 10-lineata, I, 101, 103, IV, 8, VI, 12, 18,
 VII, 1, 16, 18, VIII, 1, IX, 34, 43
 juncta, I, 103, 105, VII, 18, IX, 39, 43
 melanothorax, VIII, 10
 undecimlineata, VIII, 10
doryphora, *Lydella*, I, 111, IV, 6, Supp., 88
Dotted-legged Plant-bug, IV, 19
Douglass, J. B., on Army Worm, VIII, 39
Downy Woodpecker destroying Canker Worms,
 IV, 28, VI, 28
Dozocopa, VI, 142
Dragon Flies as enemies of Cicada, I, 26
Drasteria, VIII, 178
Drop Worm, I, 147
Dryocampa rubicunda, III, 123, V, 137
 Larval changes of, V, 138
 Natural enemies of, V, 139
 Remedies for, V, 140
 senatoria, III, 123, IV, 41
 stigma, III, 123, IV, 41, V, 141
Dujardinii, *Hypopus*, VI, 53
Dung-beetles, creaking noise made by, III, 14
 -carriers, II, 58, VI, 128
Dunkley, B. F., on Rocky Mountain Locust, VIII,
 149
Dunlap, M. L., on Rocky Mountain Locust, VII,
 155
Dunn, William, on Rocky Mountain Locust, VII,
 152, IX, 118
duodecimpunctata, *Diabrotica*, II, 66
Durand, J. B., on Rocky Mountain Locust, VIII,
 63
Duties of State Entomologist, V, 27
Dwarf Trogosita, III, 6
Dye, A. A., on Rocky Mountain Locust, IX, 69, 117
 Dr. A. H., on Army Worm, VIII, 39
Dyer, D. P., on Army Worm, VIII, 39
- E.**
- Eär-fly, II, 129
Early, Sam. H. Y., on White Grub fungus, I, 158
Earwigs, characteristics of, V, 16
East India ants, III, 8
echinopus, *Tyroglyphus*, VII, 106
Economic entomology, importance of, V, 18, VII
 (preface, p. 4).
Ecpanteria scribonia, IV, 141, 143
Ecotbia germanica, II, 10
Eddleston & Williams, manufacturers of fine ento-
 mological pins, V, 35
Edwards, C. R., on Broad-necked Prionus, II, 88
egens, *Celena*, Supp., 56
Egg-burster of *Corydalus*, IX, 127
Egg-guide, IX, 87
Egg of Abbott's Pine Worm, IX, 31
 Apple Curculio, III, 31
 Archippus Butterfly, III, 144
Egg of Beautiful Wood Nymph, VI, 89
 Broad-necked Prionus, V, 56
 Broad-winged Katydid, V, 123
 Chinch-Bug, II, 21, VII, 21
 Common May Beetle, V, 55
 Cotton Worm, II, 88
 Disippus Butterfly, III, 153
 Dominican Case-bearer, VI, 128
 Flat-headed Apple-tree Borer, VII, 73
 Gooseberry Span-worm, IX, 4
 Horned Passalus, V, 55
 Imported Currant-worm, IX, 10
 Mulberry Silkworm, movements of, IV,
 86
 Native Currant Worm, IX, 25
 Narrow-winged Katydid, V, 124
 Oblong-winged Katydid, V, 123
 Oeta compta, Supp., 58
 Pea-weevil, III, 47
 Strawberry Worm, IX, 28
 Yucca Borer, VIII, 174
Eggs in Canes and Twigs, V, 119
 of the American Tent-caterpillar, III, 118, V
 56
 Army Worm Moth, VIII, 34, 183, 184
 When laid, VIII, 40, 182, 183
 Where laid, II, 48, VIII, 34, 182
Belostoma grandis, IX, 128
Buffalo Tree-hopper, V, 121
Canker Worms, II, 94, VII, 82, 84, 86
 VIII, 13
Chinch-Bug, VII, 21
Differential Locust, VIII, 154
Frosted Lightning-hopper, V, 122
Grape Phylloxera, IV, 59, VI, 34, 38, 41,
 92, 98, VIII, 158
Harlequin Cabbage Bug, IV, 37
Hackberry Butterflies, VI, 139, 141, 148
Jumping Sumach Beetle, VI, 120, 121
Jumping Tree-hopper, V, 119
Mantis carolina, I, 170
Ecanthus latipennis, V, 119, Supp., 60
Orchelimum, V, 123
Orocharis saltator, Supp., 62
Periodical Cicada, I, 25
Rocky Mountain Locust, VII, 122
 Effects of burying at different
 depths, IX, 104
 Effects of exposure to air, IX, 104
 Effects of freezing and thawing
 on, IX, 99
 Effects of moisture on, IX, 101
 Experiments with, IX, 99
 How laid, IX, 86
 Snowy Tree-cricket, V, 120
 Tent-caterpillar of the Forest, II, 122
Tortoise Beetles, II, 60, Supp., 53
Unknown Tree-hopper, V, 122
Wheat-head Army Worm, IX, 55
Egg-Mass of Hellgrammite, IX, 120
 Rocky Mountain Locust, Philosophy
 of, IX, 87
Egg-Parasite, the Anthomyia, IX, 92
egle, *Euchetes*, I, 139, III, 133, IV, 41
Eight-spotted Forester, I, 136, II, 83, 86, VI, 94
Elachista cinereopunctella, VI, 138

- Elaphidion parallelum*, III, 6, IV, 54
villosum, III, 6
- Elaphrus ruscarius*, VIII, 52
- Elliott, F. R., on dying of Grape-vines, V, 59
- Elm Leaf-beetle, II, 10, VII, 5
Scolytus, V, 107
- Elm-tree Louse, I, 123
- Elongate Ground-beetle, I, 115
- elongatus*, *Pasinachus*, I, 115, VIII, 52
- Elytra of Coleoptera, characteristics of, V, 10
- Emery, H. D., on Climbing Cut-worm, I, 77
 Rocky Mountain Locust, VII, 138
- Emmenadia pectinata*, VI, 125
- Emphytus maculatus*, IX, 27
- Empidonax minimus*, VI, 27
- Empretia stimulea*, V, 126
- Endropia armataria*, IX, 7
- Engelmann, Dr. G., on the Grape-vines of the U. S., IV, 60, VI, 70
 on Locusts, IX, 84
- Engelmann, Theod., on Grape-vine grafting, VI, 80
 on Raspberry Root-borer, VI, 112
- Entomological collecting instruments, V, 29
 Commission, argument in favor of creating, VII (preface, p. 5), VIII, 134, 137
 pins, V, 34
- Entomologist, duties of a State, V, 27
- Entomology, definition of, V, 5
 Economic importance of, V, 18
 Importance of, as a study, V, 17
 Its advancement, V, 5
 Its relations to agriculture, V, 5
 Progress of economic, V, 19
- Entomophaga, a subsection of Hymenoptera, V, 10
- Entomophilous plants, V, 152
- entomophagus, *Tyroglyphus*, VI, 52
- Entomotaxy, V, 34
- Epargyrius tityrus*, VIII, 173
- ephemeraformis*, *Thyridopteryx*, I, 147
- Ephestia zea*, IX, 31
- Ephialtes*, I, 178
notanda, IX, 98
- Epicarvus fallax*, III, 58
formidolosus, III, 58
imbricatus, III, 58
vadosus, III, 58
- Epicauta cinerea*, Supp., 54
penysylvanica, Supp., 54
- Epilachna borealis*, IV, 18
- Epimenia, the Grape-vine, VI, 87
- epimenia*, *Psychomorpha*, III, 63, 64, VI, 87, 88, 90, 95
- Epitrix*, Supp., 53
- Eragrostis poaeoides*, VIII, 122
- Eraz*, II, 122, 123
bastardii, II, 124, IX, 98
lictor, II, 124
tabescens, II, 124
- Eriosoma*, VII, 97
lanigera, I, 121, III, 95, IV, 69, VI, 63
pyri, I, 118, III, 5, 95, 96, VI, 37, IX, 43, Supp., 59, 87
rileyi, Supp., 87
ulmi, I, 123, Supp., 87
- eriosomatia*, *Chrysopa*, I, 123
- erippus*, *Danaia*, III, 143
- Bromophila cornuta*, IX, 91
- Erwin, J. L., on Fall Army-worm, III, 110
- Erycinidae*, VI, 138
- Erynnis alsea*, VIII, 182
malvarum, VIII, 182
- Erysiphe*, V, 70
- erythrocephalus*, *Melanerpes*, VIII, 124
- erythrocerus*, *Bruchus*, III, 55, 56, Supp., 70
- erythrophthalmus*, *Coccyzus*, III, 121, VI, 27
- Euchates egie*, I, 139, III, 133, IV, 41
- Euclea*, VI, 140
penulata, V, 126
quercei, V, 126
- Eudemis*, Supp., 57
botrana, Supp., 57
- Eudryas brevipennis*, VI, 91
grata, I, 136, II, 83, VI, 88, 89, 95
unio, I, 136, II, 83, III, 63, VI, 90, 92, 95
- Eufitchia ribearia*, IX, 3
- Eulophus*, IV, 51
- Eumenes fraterna*, II, 103
- Eunemoria gracilaria*, Supp., 79
- Eupelmides*, Supp., 52
- Eupelmus*, VI, 162, Supp., 52
- Euphanessa mendica*, IX, 6
- Euplezoptera*, V, 16
- Eupsalis minuta*, VI, 113, 117
- Europe, American plants and insects acclimated in, IX, 43
- European Cattle Breeze-fly, II, 129
 Cock-chaffer, I, 157
 Meal Worm, IX, 43
 Oak Phylloxera, VI, 46, 64, VIII, 158
- Euryomia inda*, III, 6
melancholica, III, 6, V, 154
- Euryptychia*, II, 134
saligneana, II, 134, Supp., 57
- Eurytoma*, I, 52
bolteri, I, 177, Supp., 68
diastrophii, Supp., 68
- Eurytomides*, Supp., 68
- Euschemon Raflesiae*, VIII, 170
- Euschistus punctipes*, I, 113, IV, 19, 20, V, 12, Supp., 58
variolaris, Supp., 58
- Euura*, IX, 23
- Evans, J. C., on Rocky Mountain Locust, IX, 70
- Everett, H., on Chinch Bug remedy, II, 29, VII, 35
- Evolution, III, 159, VIII, 170
- exitiosa*, *Egeria*, I, 47
- Exodus of Locusts, VIII, 104
- exoleta*, *Calocampa*, VIII, 23
- Exorista flavicauda*, II, 51, VIII, 53, Supp., 60, 88
leucania, II, 50, 51, III, 116, 129, IV, 108
 VIII, 53, Supp., 60
 var. *cecropiae*, IV, 108, Supp., 60
- militaris*, II, 50, III, 129, IV, 109
- Osten-Sackenii*, II, 51
- phyceia*, IV, 40, Supp., 88
- externum*, *Calosoma*, VIII, 52
- extranea*, *Leucania*, II, 50
- extrematis*, *Cryptus*, IV, 110, 111, 123, Supp., 52
- Eyed Emperor, VI, 137

F.

- fabea*, *Bruchus*, III, 52, 55, Supp., 69, 70, 71
- fabricii*, *Lytta*, I, 99

- Fall Army-worm, III, 109, 150, VI, 17, VIII, 23, 35, 37, 48
 How it differs from the true Army Worm, III, 112, VIII, 48
 Remedies for, III, 114
 Fall Canker Worm, VII, 83, VIII, 18
 Web Worm, II, 11, III, 130
 Natural history of, III, 130
 Remedies for, III, 132
 Fairchild, H. O., on Phylloxera, VI, 83
fallax, *Epicærus*, III, 58
falsarius, *Acolithus*, II, 86
 False Chinch Bug, V, 111, VII, 46
 Indigo Gall-moth, II, 132
 Farris, M. W., on Rocky Mountain Locust, IX, 69
fasciatus, *Ecanthus*, Supp., 60
fascicularis, *Hemirhipus*, VI, 101
fastidiosa, *Chrysobothris*, VII, 71
 Fasting to avert locust injury, VIII, 96
 Faucon, Louis, on irrigation as remedy for Phylloxera, V, 72
 Faulkner, Dr. S. K., on Rocky Mountain Locust, VII, 140
femorata, *Chrysobothris*, I, 46, III, 6, VII, 71, Supp., 67
Tiphia, VI, 124
femoratum, *Spectrum*, VI, 156
femoratus, *Micropus*, VII, 22
femur-rubrum, *Ooipentus*, VII, 126, VIII, 114, 115, 116, 117, 118, 153, Supp., 89, 90
 Ferguson, J. T., on Rocky Mountain Locust, IX, 73
 Ferris, Peter, on Tent Caterpillar, III, 125
 Fever Worm, IV, 142, 144
Fidia murina, Supp., 53
viticida, I, 132, Supp., 53
vitia, Supp., 33
 Fiery Ground-beetle, I, 89, 115, II, 46, 103
 Fifteen-spotted Ladybird, IV, 17
 Figure 8 minor, I, 86
 Filbert-gall, the Grape-vine, V, 116
 Fillery, Wm. H., on Rocky Mountain Locust, IX, 75
Ambriatus, *Stiretus*, I, 114, IV, 20
 Fine, F. F., on Rocky Mountain Locust, IX, 71
 Fires for Codling Moth, IV, 27
 Fishburne, Dr. J. H., on poisoning by Colorado Potato-beetle, VII, 7
 Fisher, H. I., on Rocky Mountain Locust, IX, 85
 Fisher, J. C., on Periodical Cicada, I, 20
 Fitch, Col. H., on Rocky Mountain Locust, IX, 71
 Fitch, Dr. Asa, on Army Worm, II, 43, VIII, 25, 50
 on Bee-killer, II, 122
 on Curculio parasite, III, 24
 on Gooseberry Fruit-worm, I, 140
 on Pearl Wood Nymph, II, 84
 on Tent Caterpillar, III, 123, 127
Atchii, *Promachus*, Supp., 60
 Flat-headed Apple-tree Borer, I, 46, 47, VII, 71
 Enemies of, VII, 73
 Natural history of, VII, 72
 Remedies for, I, 47, VII, 76
 Flat-headed Borer, III, 6, VI, 107, 109
 Flea-beetle, IV, 35
 -like Negro-bug, II, 33, 34, VII, 48
 Fleas, characteristics of, V, 15
flavicauda, *Ezoriata*, II, 51, VIII, 53, Supp., 60, 88
flavicornis, *Anomalon*, III, 69
flavida, *Colaspis*, III, 41, 61, 82, IV, 34
flavifrons, *Soolia*, VI, 124
flavimanus, *Bruchus*, III, 56, Supp., 70
flavimedia, *Prodenia*, Supp., 56
 Flesh-fly, the common, VII, 180
 the *Sarracenia*, VII, 181
 Flower-beetles, III, 6
 -bug, the Insidious, VII, 41, 47
 Fly-catcher, Great-crested, destroying *Locusta*, VIII, 124
 -poison as remedy for Potato Bug, IV, 14
 Ford, S. H., apparatus of, for destroying Potato Bugs, I, 116
forcata, *Phylloxera*, VII, 118
 Forest Caterpillar, III, 129
 -flies, V, 13
 Tent-caterpillar, III, 121, 124, 128
 Forester, the Eight-spotted, VI, 94
Forficulidae, Characteristics of, V, 16
formidulosus, *Epicærus*, III, 58
formosa, *Pepsis*, II, 106
 Foster, E. S., on Broad-necked Prionus, II, 88
 Foster, Suel, on remedy for Codling Moth, I, 65
 on Potato Beetle, I, 110
 Fox-glove leaves as remedy for Gooseberry Span-worm, IX, 7
fragariae, *Analcis*, III, 42, 44, Supp., 71
Anchylopera, I, 142, Supp., 57
Tyloclerma, Supp., 72
fraterna, *Eumenes*, II, 103
 Fraternal Potter-wasp, II, 103
 Fringe-wing, VI, 50
frontalis, *Termes*, II, 11
 Frosted Lightning-hopper, V, 122
frugiperda, *Laphygma*, II, 41
Phalaena, VIII, 48
fugitiva, *Linneria*, V, 41, 141
fugitivus, *Banchus*, IV, 41
Campoplex, I, 139
Fulgoridae, V, 122
 Fuller, A. S., on Grape-vine grafting, VII, 109
 on Le Conte's Pine Worm, IX, 33
 on Seed-corn maggot, I, 164
fulvicosta, *Callimorpha*, III, 132, 134, VI, 92, Supp., 55
fulvivenosus, *Micropus*, VII, 22
fulvosa, *Laphygma*, III, 117, VIII, 49
 Fur-moth, II, 10
 Furnas, R. W., on Locust injury in Nebraska, VII, 151, 152
fusca, *Lachnosterna*, Supp., 53
fuscescens, *Turdus*, VI, 27
fuscipennis, *Mesochorus*, VII, 75
 G.
 Gad-fly, V, 13
Galeruca californiensis, II, 9, 10, 95, VII, 5, 86
Gallicola or gall-inhabiting type of Phylloxera, V, 63, VI, 34, 66
gallasolidaginis, *Gelechia*, I, 13, 173, II, 20, 183, 134, III, 158, Supp., 66, 83
 Gall-curculio of the grape, I, 131
Gallerea cereana, I, 168, II, 10
 Gall-gnat, V, 114
gallicola, *Phylloxera*, VII, 93
 Gall-louse, Grape-leaf, IV, 53, 66, 68, V, 63

- Gall-moth, False Indigo, II, 132
 The Mianamed, II, 134
 of the Golden-rod, I, 173
 -moths known to occur in the United States,
 II, 135
 -nut, V, 18
- Gall, the Grape-vine Apple, V, 114
 Filbert, V, 116
 Tomato, V, 117
 Trumpet, V, 118
- Salicis-strobiloides*, VI, 155
Vitis-corytoides, V, 116
 pomum, V, 114
 tomatos, V, 117
 viticola, V, 118
- Galle, Aphidian, on Hickory, V, 154
 How produced, VI, 70
 made by moths, II, 132
- Garber, J. B., on irrigating Grape-vines, VI, 76
- Gardener's Chronicle, article from, on Colorado
 Potato-beetle, VII, 5
 article from, on Yucca fer-
 tilization, V, 159
- garrulus*, *Ampelis*, VII, 90
- Gattine, a disease of Silkworms, IV, 91
- Gazera, VIII, 178
- Gelechia gallaeolidaginis*, I, 13, 178, II, 20, 182, 184,
 III, 158, Supp., 66, 83
longifasciella, Supp., 83
- gelechiæ*, *Microgaster*, I, 178, Supp., 66
- geminatus*, *Panicus*, I, 89
- Genitalia of male Army Worm, VIII, 30
- Geographical range of species, VII, 171, IX, 82
- Geometer of the Chick-weed, I, 179
- Geopinus incrustatus*, I, 77
- Georgetown Miner, article from, on Rocky Mount-
 ain Locust, IX, 62
- Geothlypis trichas*, VI, 27
- germanica*, *Ectobia*, II, 10
- gigantea*, *Buprestis*, IV, 141
- Gigantic Root-borers, III, 75
- Gillman, Henry, on Colorado Potato-beetle, VI, 12
- glaberrimum*, *Orchelimum*, Supp., 62
- Gladish, James E., on Rocky Mountain Locust,
 IX, 73
- glandulella*, *Holococera*, IV, 144
- Glassy Cut-worm, I, 83
 Mesochorus, II, 52, VIII, 53
 -winged Soldier-bug, III, 137
- glomeratus*, *Microgaster*, III, 167
- Glover, T., on Boll Worm, III, 106, 107, 108
 on Paris green for Cotton Worm, III,
 19
- glycerium*, *Paphia*, II, 125, 127
- Glyphe viridascens*, II, 53, VIII, 53
- Goat-weed Butterfly, II, 125, V, 145
 Additional facts in its history, V, 145
 Its winter quarters, V, 148
 Larval changes, V, 146
 Natural enemies, V, 149
 New food-plant, V, 147
 The egg, V, 146
 The larva, V, 146
 Two broods each year, V, 148
- Göerius olens*, IV, 21
- Gold-banded Tachina-fly, V, 140
- Golden-crowned Thrush destroying Canker Worm,
 VI, 27
 Robin destroying Canker Worm, VI, 28
 -rod Gall-moth, I, 173, III, 158
 Tortoise-beetle, II, 60, 62
 -winged Woodpecker destroying Canker
 Worm, VI, 28
- Goniloba*, II, 125, V, 116
- Goodman, W. S., on Army Worm, VIII, 39
 on Rocky Mountain Locust, IX,
 74, 119
- Gooseberry Fruit-worm, I, 140, II, 9
 Worms, IX, 1
 Span Worm, IX, 3
 A native species, IX, 5
 How it spreads, IX, 5
 It prefers the Gooseberry to the
 Currant, IX, 6
 Its natural history, IX, 3
 Its past history, IX, 5
 Parasites, IX, 6
 Remedies, IX, 6
 The moth is closely imitated,
 IX, 6
- Gordii*, VIII, 124
- Gordius aquaticus*, IX, 98
- Gortyna nebris*, Supp., 56
nitela, I, 92, III, 105, VIII, 37, Supp., 56
- Gothic Dart, I, 81
- gracilaria*, *Eunemoria*, Supp., 79
- Grafting, VI, 79
- Grain Bruchus, III, 45, 50, 51, 54
 Plant-louse, II, 5, 10, 16
 Sylvanus, III, 6
 Weevil, II, 10, III, 60
- grallator*, *Cryptus*, VII, 75
Labena, VII, 75
- graminis*, *Bombys*, II, 44
- granarius*, *Bruchus*, II, 11, 14, III, 50, 51
Sitophilus, II, 10, III, 60
- Grand-daddy-long-legs, IV, 17
- Grandfather-Gray-Beards, IV, 17
- grandis*, *Lebia*, III, 100, Supp., 52
Stizus, I, 27, Supp., 52
- granulata*, *Tettix*, VIII, 150
- Granulated Grouse-locust, VIII, 150
- Grape-berry Moth, III, 90
 -cane curculio, III, 60
 Gall curculio, I, 131
 Remedy for, I, 132
- Codling, I, 133
 Remedy for, I, 135
- Curculio, I, 128, III, 60
- Fidia, V, 108
- Gall curculio, I, 181
- Gall-louse, III, 90, 92, 96, IV, 66
 -grower, a new friend to the, III, 137
 leaf-louse, III, 88, 94
 Trumpet-gall, V, 118
- Grape Phylloxera, III, 84, IV, 55, 67, V, 57, 63, VI,
 30, VII, 41, 90, VIII, 157, IX, 43
- Bibliographical, VI, 30
- Biological, VI, 33
- Completion of its natural history, VII, 90,
 VIII, 157
- Conclusions, IV, 70, VI, 65

- Grape Phylloxera**—Continued.
 Different forms which the insect assumes, VI, 33, VII, 93
 Direct remedies, VI, 55, VII, 105
 Early existence in America, VI, 82, 83
 First appearance in California, VI, 82
 False theories, VI, 60
 Gall-inhabiting type, VI, 34, 66, 67
 Grafting as a means of counteracting the work of, IV, 65, VII, 108
 Impregnated egg not necessarily hibernial, VI, 86
 Injury caused by it in America, VI, 58, VII, 99
 France, VII, 103
 Its spread in Europe, V, 63, VII, 104
 Male louse, V, 71
 Means of contagion from one vine to another, IV, 64, V, 69
 Mode of spreading, VI, 45
 Mortality of vines caused by it, V, 57
 Natural enemies, VI, 50, VII, 106
 New theories, V, 67
 Occurrence in Southern States, VIII, 164
 Other preventive measures, VI, 50
 Practical considerations, IV, 67, VI, 44, VIII, 163
 Probable reasons why its injuries are greater in Europe than with us, IV, 66
 Prophylactic means of coping with the disease, VI, 48
 Range of the insect in America, V, 62, VI, 57, VII, 101
 Ravages of, in California, VI, 82, VIII, 163
 Real cause of disease, VI, 85
 Remedies, IV, 63, V, 71, VI, 55, VII, 105
 Resolutions concerning destruction of, VIII, 165
 Résumé of its natural history, IV, 69
 Root-inhabiting type, IV, 58, VI, 38, 66
 Sexed individuals, VII, 86, 93, VIII, 158
 Specific identity of the root-inhabiting and leaf-inhabiting types, IV, 57, VII, 94
 Specific identity of the American and European insects, III, 86, IV, 57
 Susceptibility of different vines to the disease, IV, 60, V, 64, VI, 46, VII, 106
 The more manifest and external effects of the disease, VI, 44
 Transient nature of the galls, V, 63
 Type *gallicola* or gall-inhabiting, VI, 34, 66, 67
 Type *radicicola* or root-inhabiting, VI, 38, 68
 Where do the winged females lay their eggs? VII, 96
 Why the insect is more injurious in Europe than here, VI, 59
- Grape-root-borer**, I, 124
 Remedies for, I, 128
- Grape-seed Curculio**, I, 129
 -seed Maggot, II, 92
- Grape-vine Apple Gall**, V, 114, 115
 Blue Caterpillars of, I, 136, II, 79
 Colaspis, III, 44, 62, 81, IV, 34
 Epimenis, III, 63, 65, VI, 87
 Flea-beetle, III, 79
 Fidia, I, 132, 133
 Filbert Gall, V, 116
 Hog-caterpillar of, II, 71
 Insects injurious to, I, 124, II, 71
- Grape-vine Gall-louse** (see Grape Phylloxera)
 Leaf-folder, III, 61
 Leaf-gall-louse (see Grape Phylloxera)
 Plume, I, 137, III, 65, 66, 67, 68, IV, 129
 Proctos, II, 85, V, 134
 Root-borer, I, 124, III, 75
 Tomato Gall, V, 117
 Trumpet Gall, V, 118
- Gropholitha oculana*, III, 6
Graphiphora, I, 79
Grafts, III, 103, V, 149
Graptodera, Supp., 53
Grasserie, a disease of Silkworms, IV, 91
Grasshoppers, a division of Orthoptera, V, 14
grata, *Euclyptus*, I, 136, II, 63, VI, 88, 90, 95
grataria, *Hamatopsis*, I, 119
 Gray, Alfred, on Rocky Mountain Locust, VII, 148, 149
 Gray's Improved Sprinkler, VII, 15
 Greasy Cut-worm, I, 80
 Great-created Fly-catcher destroying Locusts, VIII, 124
 Lebia, III, 100
 Leopard moth, IV, 141
 Green Apple-leaf Tyer, IV, 46
 -head Fly, II, 128
 larva of White-lined Morning-sphinx, VIII, 122
 striped Locust, VIII, 149
 Maple Worm, V, 137
 Larval changes, V, 138
 Natural enemies, V, 139
 Remedies, V, 141
- Gregg, Jacob, on Rocky Mountain Locust, IX, 73
grossularis, *Pempelia*, I, 140, II, 9, Supp., 57
grossulariata, *Abrazas*, IX, 5
grossulariella, *Phycia*, Supp., 57
 Grote, A. R., on poisonous properties of *Doryphora*, VIII, 10, 11
- Ground-beetle larva** preying on *Curculio* larvæ, I, 59
 larvæ preying on locust eggs, IX, 97
 The Elongate, I, 115
 The Fiery, I, 89, 115
 The Murky, I, 115
 The Pennsylvania, I, 59
 The subangular, I, 58
- Ground-beetles** destroying Canker Worms, II 103
 Locusts, IX, 98
- gryllaria*, *Astoma*, VII, 175, Supp., 63
Gryllidæ, stridulating apparatus of, VI, 154
Gryllus erythropus, VII, 126
 niger, II, 152
Gubernaculum ovi, IX, 87
Guerinii, *Attacus*, IV, 112, 113
Guiraca ludoviciana, V, 54
guttata, *Ossidea*, II, 60, 63
Coptocycla, Supp., 53
- HN.
- Habit, change of, III, 91
 Hackberry Butterflies, VI, 136
Hadena, I, 68, Supp., 56
 amputatrix, I, 87
 chenopodii, Supp., 76, 77
 subjuncta, I, 84

- Haeckel, Prof. E., on the unity of nature, III, 174
Hæmatopis grataria, I, 179
 Hair-worms, IX, 98
Halesidota Harrisii, III, 127
 tesselata, III, 127
 Half-winged Bugs, characteristics of, V, 12
 Hall, William, on Chinch Bug and Locust, VIII, 76
Haltica chalybea, I, 101, III, 79, 81, Supp., 53
 cucumeris, I, 101, II, 57, V, 112, Supp., 53
 nemorum, I, 101
 pubescens, I, 101
 rhois, VI, 122
 stolida, VI, 122
 striolata, III, 44
 Ham-beetle, the Red-legged, VI, 96
 Hammond, A. C., on Apple-leaf Skeletonizer, IV, 45
hammondi, *Acrobasis*, III, 7
 Pempelia, IV, 44, 43, Supp., 80
 Hammond's Knot-horn, IV, 45
 Hanan, B., on Oyster-shell Bark-louse, V, 74
 Hand-maid Moth, III, 124
 Hanway, James, on Rocky Mountain Locust, VIII, 102
 Hardin, Gov. C. H., proclamation by, VIII, 95
 Harlequin Cabbage-bug, IV, 35
 Harman, M. B. W., on Rocky Mountain Locust, IX, 74
Harmonia picta, Supp., 52
Harpactor cinctus, I, 114, VII, 41, Supp., 58
 Harpalus? Larvæ feeding on locust eggs, IX, 97
Harpalus caliginosus, I, 115, VIII, 52
 pennsylvanicus, I, 59, VIII, 52, IX, 98
 Harris, Dr. T. W., on hibernation of *Disippus* Butterfly, III, 155
 on Oyster-shell Bark-louse, V, 79
 on Poplar Spinner, II, 19
 on Tent-caterpillar, III, 121
Harrisii, *Aspidiotus*, I, 7, II, 9, Supp., 60
 Halesidota, III, 127
 Harris's Bark-louse, I, 7, II, 9
 Harvest-flies, II, 131
 -men, IV, 17
 mites, VI, 122
 Hatful Locust, VII, 188, 190
 Hawk Moth, II, 76, IV, 86, V, 12
 Hay-worm, the Clover, VI, 102
 Hagen, Dr. H. A., on the distinction of Cicadae, I, 21
 Head Maggot, I, 161
 Heard, J. M., Boll-worm Moth Trap, III, 109
 Heart-worm of cabbage, II, 107
 Heavy rains destructive to the Chinch Bug, II, 24
 Hecker, Fred., on remedy for Potato-beetle, VIII, 4
 Hedge-hog Caterpillar, IV, 143, 144
Hedya scudderiana, Supp., 57
Heliconiæ, III, 103
Heliconius melpomene, III, 173
 thelxiope, III, 173
Heliophila, VIII, 22
Heliothis armigera, III, 45, 104, IV, 129
 Hellebore for Currant worms. IX, 7, 13, 14, 15
 Potato bugs, IV, 14
 White Pine Worm, IX, 32
 Hellgrammite, V, 142, IX, 125
 Characters of the young larva, IX, 127
 Hellgrammite—Continued.
 Eggs hitherto supposed to belong to it, IX, 128
 Its curious egg-mass, IX, 126
 The larva lives in rapid flowing streams, IX, 128
 Where and how the eggs are laid, IX, 127
Helminthophaga ruficapilla, VI, 27
 Helius, Abraham, on Rocky Mountain Locust, VIII, 91
Hemileuca californica, V, 128
 maia, V, 127
 nevadensis, V, 128
 Hemiptera, classification of, V, 12
 Preparing of for cabinet, V, 34
Hemirhipus fascicularis, VI, 101
Hemiteles cressonii, I, 177, Supp., 65
 nemativorus, IX, 17
 (?) *thyridopterigis*, I, 150, Supp., 65
Hentzii, *Mygale*, II, 106
herbimacula, *Oelana*, I, 86
herilis, *Agrotis*, Supp., 55
 Herschell, C., on Locusts, VIII, 151
herse, *Apatura*, VI, 136, 140, 148
 Herse Butterfly, VI, 148
Hesperia, VIII, 175
Hesperides, VIII, 176
 Hessian Fly, II, 10, 16, 17, 19, III, 110, 111, IV, 97, V, 13, 25, VII, 22, 27, 36
 parasite, III, 120
 Heterocera, a section of Lepidoptera, V, 12
 Heteromera, a section of Coleoptera, V, 10
 Heteroptera, a section of Hemiptera, V, 12
 Hewitt, H. L., on Rocky Mountain Locust, IX, 69
hibisci, *Bruchus*, Supp., 70, 71
 Hickman, G. B., on Rocky Mountain Locust, IX, 69
 Hickory Bark-borer, V, 62, 103, 104
 Natural enemies of, V, 106
 Remedies for, V, 107
 Hickory Borer, VI, 101
hilarana, *Cochylis*, I, 175, II, 135
 Hill, John, on Rocky Mountain Locust, IX, 75
Hipparchia, VI, 143
Hippobosca, VII, 91
Hippoboscidae, V, 13
Hippodamia convergens, I, 112
 glacialis, IV, 18
 maculata, I, 112, II, 25, V, 149, VII, 39, Supp., 52
 13-*punctata*, I, 112
histrionica, *Murgantia*, IV, 35
 Strachia, IV, 35
 Hoag, C. R., on Flat-headed Borer, VII, 74
 Hoag, I. N., on silk culture, IV, 80
Hockeria perpulera, II, 53
 Hoffmeister, A. W., on Colorado Potato-beetle, VII, 14
 on Army Worm, VIII, 29
 Hogan, John H., on Grape-root Borer, I, 125
 Hog-caterpillar of the vine, II, 71, 75
 Hogs as Apple-worm destroyers, I, 65
 Curculio destroyers, I, 59
Holcocera glandulella, IV, 144, 145
 Holmes, Wm. C., on Tile-horned Prionus, II, 90
holosericeum, *Trombidium*, VII, 175
 Holsinger, Frank, on destroying Locusts, VIII, 127
Holt County Sentinel, article from, on Rocky Mountain Locust, VIII, 69

- Homely Geopinus, I, 89
Homocerosoma, Supp., 57
 Homoptera, a section of Hemiptera, V, 12
Homopus, VII, 106
 Honey-bee, insect enemies of, I, 166, VI, 101
 Honey locust seed-weevil, III, 45
Honora, Supp., 57
 Hooten's Curculio-catcher, III, 22, 23
 Hopkins, B. F., on Rocky Mountain Locust, VII, 151
Hoplophora areolata, VI, 53, 81, VII, 106
 contractilis, VI, 54
 Hopps, Michael, on remedy for Chinch Bug, II, 30
hordeti, *Icosoma*, II, 92
 Horned Lark destroying Locust eggs, IX, 91
 Horned Passalus, IV, 139
 eggs of, V, 55
 Horner, C. C., on machine for destroying Locusta, VIII, 129
 Hornet, sting of the, I, 27
 Horn-tails, V, 10
 Hostetter, C. J., on Rocky Mountain Locust, IX, 71
 House Pigeon destroying Ca
 Howard, Sanford, on remedy for Canker Worm, II, 100
 How to collect, preserve, and study insects, V, 29
 counterwork noxious insects, V, 23
 transmit insects, V, 44
 Huggins, J., on Canker Worm, II, 101
 Hull, Dr. E. S. on Canker Worm, II, 101
 on Grape-vine Flea-beetle, III, 81
 on scab in Apples, II, 7
 Hull's Curculio-catcher, III, 19
 Modification of, V, 25
 Hurlburt, J., on Colorado Potato-beetle, IV, 9
 Husmann, Geo., on grape-vine grafting, VII, 109, 110, 111
 pruning, VI, 84
 on importance of Phylloxera
 discoveries, IV, 55
Huttoni, *Bombyx*, IV, 85
Hyalophora cecropia, IV, 103
Hybernica, VIII, 17
 Hydrocorissæ, a division of Heteroptera, V, 12
Hylecæus americanus, III, 7
 Hymenoptera, characters and classification of, V, 9
Hyperchiria io, V, 133
 varia, V, 133
Hyperaspis normata, V, 100
Hyphantria cunea, Supp., 55
 punctata, Supp., 55
 textor, III, 130, 132, Supp., 55
Hypogymna dispar, II, 10
Hypopus, VI, 52, VII, 106
 dujardini, VI, 53
Hypsopigia, VI, 105
- I.
- Ichneumon brevipennis*, IX, 55
 leucanica, II, 53, VIII, 54
 obsolutus, IX, 55
 pullatus, III, 69
 signatipes, III, 69
 rubicyanus, III, 69
 unifasciatus, III, 71
Ichneumonidæ, III, 27, 28, Supp., 65
Icterus Baltimore, VI, 27
 Icy Ladybird, IV, 18
 Idol, J. K. P., on Rocky Mountain Locust, IX, 74
idya, *Apatura*, VI, 145
ignota, *Rhodites*, I, 13
 Illinois Lace-wing, II, 26, VII, 39
 Locust flights in, VIII, 151
illinoensis, *Ohrysopa*, II, 26, VII, 39, 40
 Imbricated anout-beetle, III, 58
imbricator, *Pemphigus*, I, 121
imbricatus, *Epicærus*, III, 58
imbricornis, *Prionus*, II, 89, III, 6, 75
immarginatus, *Icosoma*, VII, 22
 Importance of Entomology as a study, V, 17
 Imported Apple-worm, I, 108
 Cabbage Worm, II, 107
 Imported Currant Worm, II, 13, VI, 43, 149, IX, 7
 Descriptive, IX, 21
 It furnishes an interesting instance of defunc-
 tionation of special parts, IX, 19
 It presents a forcible example of Arrhenotoky
 IX, 18
 Its introduction and spread, IX, 8
 Its natural history, IX, 9
 Natural enemies, IX, 17
 Preventive measures, IX, 13
 Remedies, IX, 13
 Imported vs. Native American Insects, II, 8, 106,
 107, VII, 5
 Imported Onion-fly, II, 9
 Oyster-shell Bark-louse, II, 9
 Improved Patent Insect Destroyer, IV, 15
impura, *Leucania*, VIII, 38
inaequalis, *Colletes*, I, 128, Supp., 54
incertus, *Melanotus*, III, 6
 Incrassated Geopinus, I, 77
incrassatus, *Geopinus*, I, 77
inda, *Euryomia*, III, 6
indagator, *Perilitus*, IV, 43, Supp., 66
indagatrix, *Pimpla*, IV, 43
indecisa, *Ægiale*, VIII, 179
 Indigo-bird destroying Canker Worm, VI, 27
 Indian Territory, locusts in, VIII, 88, IX, 76, 78
indiginella, *Myelois*, IV, 38
inermis, *Agrotis*, I, 72, 74, II, 50, III, 15, 129, VIII, 37
 Supp., 55
infecta, *Celæna*, Supp., 56
 Inflating Chalcis fly, I, 176
 Influence of food in determining sex, VIII, 19
 Influence of wind in determining the course of
 locust swarms, IX, 81
 Ingalls, Senator, Introduction of bill in Congress
 for destruction of injurious insects, V, 133
 Innoxious insects, I, 172, II, 123, III, 140, V, 142, VI,
 127, VIII, 169, IX, 125
inornata, *Amphipyra*, III, 75
 Tiphia, VI, 123
inquisitor, *Cryptus*, I, 150
Insecta, number of joints in, V, 7
 Insect enemies of the Honey-bee, I, 166
 domestication, IV, 85.
 What is an? V, 5
 Insects, Breeding, V, 41
 Cabinet and boxes for, V, 87
 How to counterwork noxious, V, 23

- Insects, How to collect, preserve, and study, V, 29
transmit, V, 42, 44
Imported and Native American, II, 8
Infesting the Apple-tree, III, 5, 6
Grape-vine, I, 124, II, 71, III, 61, IV, 53, V, 114, VI, 30
Potato, I, 91
Sweet-potato, II, 56
Mounting, for cabinet, V, 34
Rearing, V, 41
Relation of to agriculture, V, 18
Relaxing dry, V, 41
Text-books on, V, 42
Transmitting, V, 44
- insidiosus*, *Anthrenus*, II, 27, 32, VI, 51, VII, 41, Supp., 58
Insidious Flower-bug, II, 27, 32, VI, 51, VII, 41, 47
Instinct, Curious, III, 156
Philosophy of, V, 83
vs. reason, V, 83, 157
interrupta, *Acronycta*, II, 121, Supp., 73
interruptus, *Passalus*, IV, 141
Io Moth, V, 138
Food plants, V, 136
Larval changes, V, 135
Parasites, V, 136
Iowa, Rocky Mountain Locust in, VIII, 81, IX, 63
iris, *Apatura*, VI, 186
Irrigation as remedy for Chinch Bug, VII, 31
Phylloxera, IV, 60, VI, 55
Rocky Mountain Locust, VII, 182
- irritans*, *Leptus*, VII, 177
Irritating Harvest Mite, VII, 177
property of caterpillars, V, 131
various insects, VI, 70
- Irvine, Clarke, on Rocky Mountain Locust, VIII, 105, IX, 72
isabella, *Arctia*, IV, 143, Supp., 55
Isabella Tiger Moth, IV, 143
Iske, Anthony, Machine for destroying Potato-beetles, VIII, 4
isocrates, *Thecla*, VIII, 177
Isosoma hordae, II, 92
vitis, II, 92, 93
italicus, *Caloptenus*, VII, 133, VIII, 140
Ithomia, III, 161, 165
Ithycerus noveboracensis, III, 6, 57
Ituna, III, 103
- J.
- taculifera*, *Agrotis*, I, 82, 83, Supp., 56
Jarring as remedy for Apple-worm, IV, 25
Jefferson City Tribune, article from, on Army Worm, VIII, 50
article from, on Rocky Mountain Locust, VIII, 108
Jewett, D. T., on growing European grape-vines, VI, 77, 78
Johnson, B. F., on Locusts, VIII, 152
Johnson, C. V., on Colorado Potato-beetle, VIII, 10
Johnson, Prof. J. W., on Paris Green, VII, 11
Johnson, J. W., Sprinkling machine invented by, VI, 20
Joint-worm Fly, II, 92
Jones, H. L., on Rocky Mountain Locust, VII, 150
- Jordan, C. W., on Rocky Mountain Locust, IX, 70
Journal of Agriculture, article from, on Fall Army Worm, III, 103, 110
article from, on Pickle Worm, II, 69
article from, on remedy for Peach Borer, I, 49
juglandis, *Acrobasis*, IV, 42, 43, Supp., 67, 80
Conotrachelus, Supp., 54
Phycia, Supp., 80
Jumping Sumach-beetle, VI, 118
Natural history of, VI, 120
Remedies for, VI, 121
Jumping Tree-cricket, I, 133, V, 119
juncta, *Doryphora*, I, 103, 105, VII, 18, IX, 39
juvenalis, *Nisoniades*, III, 155
- K.
- kansanus*, *Brachinus*, IV, 21
Kansas acts to encourage the destruction of Locusts, IX, 112, 113
Bombardier-beetle, IV, 21
Kansas City *Journal of Commerce*, articles from, on Rocky Mountain Locust, VIII, 53, 107
Times, article from, on Rocky Mountain Locust ravages, VIII, 74
Kansas Farmer, article from, on Army Worm, III, 110
article from, on remedy for Locusts, VII, 184
Kansas, legislation in, regarding Locusts, IX, 112, 113
Locusts in, VIII, 76, IX, 65
Silk culture in, IV, 82
State relief work, VIII, 78
Katydid, Angular-winged, VI, 155
Oviposition of, VI, 156
Eggs of, VI, 155, 158
Earlier stages of, VI, 158, 161
Song of, VI, 159
Natural enemies of, VI, 162
Katydid, Broad-winged, VI, 167
Oviposition of, VI, 167
Katydid, Narrow-winged, V, 124, VI, 164
Oblong-winged, V, 123, VI, 169
Katydid, VI, 150
Characteristics of, VI, 154
Oviposition of, VI, 155, VIII, 37
Stridulation of, VI, 154
Kaucher, Wm., on Rocky Mountain Locust, IX, 72
Kayser, A., on poisonous qualities of *Doryphora*, VIII, 11
Kedzie, Prof. W. K., on influence of Paris Green on soil, VII, 12, VIII, 6
on the use of Paris Green, V, 53, VIII, 6
Kelsey, S. J., on remedy for Chinch Bug, VII, 42
on Rocky Mountain Locust, VII, 135, 164, 193
Kerosene as remedy for Canker Worm, VIII, 20
Flat-head Apple-tree Borer, VII, 78
Locusts, VIII, 130
Killing insects intended for cabinet, V, 32
Kimbertin, J., on Rocky Mountain Locust, IX, 68

King, Bennet, on Rocky Mountain Locust, IX, 72
 King Bird destroying Canker Worm, VI, 27
 Kirkpatrick, J., on Army Worm, II, 43
 Klæger, W., insect pins manufactured by, V, 34
 Klippart, H. J., on Army Worm, II, 47
 Knot-horn, Hammond's, IV, 45
 Knotweed Geometer, I, 179
 kollari, *Egiale*, VIII, 179
 Krimminger, W. B., on Rocky Mountain Locust, VIII, 63
 Kuwa jirami, IV, 100

L.

Labena grillator, VII, 75
Labium of Hymenoptera, V, 9
 Lace-wing Fly, IV, 45
 The Illinois, II, 25
 The Weeping, II, 26, VI, 51
 Lacewing larva, I, 57, II, 27
Lachnosterna fusca, Supp., 53
 quercina, I, 57, 67, II, 19, V, 55, VI, 123, VII, 27, Supp., 53
 Ladybird, II, 25, VI, 51
 The Convergent, I, 112
 The 15-spotted, IV, 17
 The 9-spotted, I, 112
 The Spotted, I, 112
 The 13-spotted, I, 112
 Ladybirds, I, 112, II, 27, V, 11, 27
Laërrias, Supp., 54
Lagoa crispata, V, 126
 opercularis, V, 126
Lalage, V, 140
 Lancaster Farmer, article from, on Colorado Potato-beetle, IX, 35
 Lance Rustic, I, 80
 Land Bugs, a division of Heteroptera, V, 12
lanigera, *Eriosema*, I, 121, III, 95, IV, 69, VI, 63
 Schizoneura, Supp., 59
 Langworthy, A. J., on Apple-leaf Bucculatrix, IV, 50
 on Army Worm, VIII, 42
Laphygma frugiperda, II, 41
lardarius, *Dermestes*, VI, 100
 Larder-beetle, VI, 100
 Large Black Bear, IV, 141
 Larva, the second stage of insect development, V, 7
 Larvæ, Stinging, V, 125
Lasioplera vittis, V, 117
lateralis, *Corimelana*, II, 35
 Ophion, II, 53
laticollis, *Prionus*, II, 87, III, 6, 75
latipennis, *Ecanthus*, Supp., 60, 61
 Latrelle, life of, saved by an insect, VI, 101
Latreillia, V, 140
 Law of priority, IV, 55, VII, 143, VIII, 179, IX, 7
 Lay, J. H., on Rocky Mountain Locust, IX, 69
 Leaf-beetle, the Elm, VII, 5
 -bug, the Ash-gray, VII, 47
 -crumpler, III, 7
 the Rascal, IV, 38, VII, 81
 -folder, the Lesser, IV, 47
 -hoppers, III, 6
 mistaken for Locusts, VIII, 150
 -roller of the Strawberry, I, 142

Leaf-rollers, III, 6
 -tyer, the Green Apple, IV, 46
 Least Pewee destroying Canker Worm, VI, 27
 Le Baron, Dr. Wm., description of Locust Mite by, VII, 176
 on *Aphelinus mytilaspidis*, V, 87
 on Apple Worm, VI, 10
 on Pine-leaf Scale, V, 84
 on remedies for Canker Worm, VI, 24
Lebia atriventris, VIII, 3, Supp., 52
 grandis, III, 100, VIII, 3, Supp., 52
Lecanides, V, 85, 92
Lecanium aceris, V, 92
 LeConte, Dr. J. L., on the use of mineral poisons as insecticides, VII, 8
lecontei, *Callimorpha*, III, 134, VI, 92, Supp., 55
 LeConte's Pine Worm, IX, 32
 Descriptive, IX, 33
 Habits of, IX, 33
 Legged Maple Borer, VI, 107
 Legislation against injurious insects, VIII, 132
 to avoid locust injury, IX, 111
 to create national entomological commission, VIII, 133
Lema trilineata, I, 99, II, 58, III, 14
 Leopard Moth, the Great, IV, 141
Lepidoptera, characteristics of, V, 11
 preparing of, for cabinet, V, 38
Lepidosaphes, I, 9, V, 91
leporina, *Acronycta*, II, 121, Supp., 73
Leptalis, III, 161, 165
Leptinotarea, VIII, 2
Leptus, VI, 52
 americanus, VI, 122
 irritans, VI, 122, VII, 177
lepusculina, *Acronycta*, II, 121, Supp., 73
 Lesser Apple Leaf-folder, IV, 47, 48
lesueuri, *Chrysobothris*, VII, 71
 Letterman, G. W., on Colorado Potato-beetle, IX, 35
Leucania albilinea, IX, 50, 55
 comma, VIII, 43
 extranea, II, 50, VIII, 34
 harveyi, IX, 50
 impura, VIII, 38
 lithargyria, VIII, 38, 43
 phragmatidicola, IX, 57
 turca, VIII, 43
 unipuncta, I, 109, II, 5, 11, 37, 53, V, 25, VII, 22, 24, 29, 182, IX, 47, Supp., 76
Leucania, II, 51, 52
leucania, *Ichneumon*, II, 53, VIII, 54
 Ezoriata, II, 50, 51, 52, III, 116, 129, IV, 108, VIII, 53, Supp., 60
Leucopis, VI, 51
leucoptera, *Ourivirostra*, VI, 27
leucopterus, *Micropus*, II, 15, VII, 19, Supp., 58
leucostigma, *Orgyia*, I, 144
 Lewelling, H., on Apple Curculio, III, 35
Libellula, II, 46
Libellula trimaculata, V, 14
Victor, *Eraz*, II, 124
 Lightning-hopper, Frosted, V, 122
luna, *Attacus*, IV, 123, 138
Limacodes, III, 150
 scapha, V, 126

- Lime, air-slacked, as remedy for Potato beetle, IV, 14
as remedy for Locusts, VIII, 130
Carbolate of, as remedy for Potato-beetle, IV, 14
- Limenitis*, III, 168, 169
 arthemis, III, 171
 brederi, III, 171
 disippus, III, 153, 171, V, 146, Supp., 66
 lorquini, III, 171
 missippus, III, 167, VI, 145
 proserpina, III, 171
 sibylla, III, 171
 ursula, III, 163, 167, 171
 weidemeyerii, III, 171
- limenitidis*, *Microgaster*, III, 158, Supp., 66
Limneria fugitiva, IV, 41, V, 133, 141
 lophyrus, IX, 32, Supp., 65
- Linneceum, Dr. Gideon, on Harlequin Cabbage-bug, IV, 36
- Lincoln (Neb.) *Journal*, article from, on Rocky Mountain Locust, VIII, 108
- linearis*, *Coreus*, II, 113
 Phytocoris, II, 113
- lineata*, *Deilephila*, III, 140
lineatella, *Prodenia*, Supp., 56
lineola, *Tabanus*, II, 128
- Lintner, J. A., on cabinet boxes for Lepidoptera, V, 38
on larva of *Eudryas unio*, VI, 93
on Hog-caterpillar of the vine, II, 72
on sexual characters in butterflies, III, 103
on stinging larvæ, V, 131
- Liparis auriflua*, V, 126
- List of birds which feed on Canker-worm, VI, 27
- Lithacodes fasciola*, V, 126
lithargyria, *Leucania*, VIII, 38, 43
Lithophane, Supp., 75
- Little, Joe. T., on White Pine Worm, IX, 30
- Little-lined Plant-bug, II, 113
- Loafman, Dr. J. M., on Rocky Mountain Locust, IX, 75
- Lobesia botrana*, Supp., 57
Lobophora, IV, 129
- Locust Flights east of the Mississippi, IX, 81
Flights in Illinois, VIII, 151
Mite, VII, 175
The Atlantic Migratory, VII, 169
The Clumsy, VIII, 148
The Colorado, VII, 188
The Differential, VII, 124, 173
The Green-striped, VIII, 149
The Hateful, VII, 188, 190
The Migratory, VII, 133
The Red-legged, VII, 125, 188
The Rocky Mountain, VII, 121, VIII, 57, IX, 57
The Seventeen-year, VII, 27
The Thirteen-year, VII, 27
The Two-striped, VII, 173
- Locusta erythropus*, VII, 126
Locustidae, VI, 124, 150
Locusta, V, 14, VI, 153
as food for man, VIII, 143
- Locusts not a divine visitation, VIII, 97
vs. grasshoppers, VI, 150, 153
- Lodi Potato Pest Poison, VIII, 7
- Lomechusa*, IV, 22
- Long, Dr., on remedy for Canker Worm, II, 101
- Long, Levi, on Rocky Mountain Locust, VIII, 99, 102, IX, 71
- Long-horned Beetles, injurious to fruit trees, III, 6
stridulating noise produced by, III, 14
- Boring Beetles, larval habits of, II, 91
- longifasciella*, *Gelechia*, Supp., 83
longispinus, *Dactylopius*, IV, 70, VI, 63
Long-tailed Ophion, IV, 107, 129, V, 136
lophyrus, *Limneria*, IX, 32, Supp., 65
Lophyrus, IX, 12
 abbottii, IX, 29, 32, Supp., 65
 abietis, IX, 33
 americanus, IX, 34
 compar, IX, 34
 fabricii, IX, 34
 lecontei, IX, 31, 32
- lorquini*, *Limenitis*, III, 171
Loxopeza, Supp., 52
Loxotania roseaana, III, 6
Lucanus elaphus, V, 145
Lukens, W. E., on Strawberry Leaf-roller, I, 148
luna, *Actias*, IV, 123
 Attacus, IV, 74
Luna Silkworm, IV, 123
larval changes of, IV, 124
- lunatus*, *Cratoparis*, III, 10
Lycænidæ, VI, 138
lycaon, *Apatura*, VI, 136, 146, 148
 Pholus, II, 76
 Sphinx, II, 76
- lycarum*, *Agrotis*, Supp., 77
Lycorea, III, 103
Lycosa, IX, 98
Lyctus opaculus, IV, 54
Lyda, IX, 10
Lydella doryphora, I, 111, IV, 6, IX, 40, Supp., 88
Lygæus leucopterus, VII, 21
Lygus robinæ, V, 154
- Lyman, Jos. B., on Cotton Worm, II, 39, 40, Supp., 88.
- Lymezylon navale*, V, 19
- Lytta ænea*, III, 6
 atrata, I, 98, Supp., 54
 cinerea, I, 97, Supp., 54
 fabricii, I, 99
 marginata, I, 98, Supp., 54
 murina, I, 98, Supp., 54
 vittata, I, 96
- III.
- Machines for catching Curculio, I, 60, III, 18, V, 25
Colorado Potato-beetle, I, 117, VI, 14, VIII, 4
- Macrobasis unicolor*, Supp., 54
Macrocentrus delicatus, V, 50
Macrodaetylus subspinosus, V, 108
macrurum, *Ophion*, IV, 107
maculalis, *Desmia*, III, 61
maculata, *Hippodamia*, I, 112, II, 25, VII, 39, Supp., 72
 Vespa, Supp., 48
maculosa, *Dendroica*, VI, 27

- Madarus ampelopsidis*, I, 132
 ritis, I, 131, Supp., 71
magnus, *Brachypeplus*, VIII, 148
Maia Moth, V, 127
 Its Eggs, V, 128
 Issuing of the moth, V, 132
 The larva, V, 129
 Larval changes, V, 129
 The pupa, V, 131
 The sting of the larva, V, 131
 Natural enemies, V, 132
maia, *Saturnia*, IV, 41
Maine Farmer, article from, on Canker Worm, II, 100
malii, *Acarus*, II, 6
malii, *Aphis*, II, 6, 10, III, 6
 Molobrus, III, 6
malivora, *Tortrix*, IV, 47, Supp., 82
malus, *Acarus*, I, 16
malvarum, *Erynnis*, VIII, 182
Mamestra, I, 68, III, 123
 picta, II, 112
Mandibulæ of Hymenoptera, V, 9
Mandrake as remedy for Potato Bugs, IV, 15
Manitoba, Rocky Mountain Locust in, VII, 155, VIII, 89
Mankato Review, article from, on Rocky Mountain Locust, IX, 60
Mann, B. P., on Canker Worm, VI, 28
Mantis carolina, I, 169, III, 68, IX, 98
mantivora, *Sarcophaga*, VII, 180
Many-banded Robber, I, 114, VII, 41
Maple, J. W., on Rocky Mountain Locust, IX, 71
Maple Borer, the Legged, VI, 107
Maple Worm, the Green-striped, V, 137
 Enemies of, V, 139
 Larval changes of, V, 138
 Remedies for, V, 141
marginata, *Lytta*, I, 96, Supp., 54
marginatum, *Trochilium*, Supp., 72
Margined Blister-beetle, I, 98
maria, *Chalcis*, IV, 109, 110, 123
Mark, Calvin A., on Rocky Mountain Locust, VIII, 102
Marrupialea, II, 12
Mary Chalcis-fly, IV, 109, 129
Maryland Yellow-throat, destroying Canker Worm, VI, 27
Mascicera, III, 150, IV, 129
mazillonus, *Brenthus*, VI, 116
Maxwell, J. H., on Rocky Mountain Locust, IX, 69
Maxwell, J. R., on the use of Paris green, VI, 19
May Apple for Potato Bugs, IV, 15
May Beetle, I, 156, II, 19, IV, 16, VII, 27
 Eggs of, V, 55
May-flies, III, 8, V, 143
Maynard, C. J., list of birds destroying Canker Worm, VI, 27
McAfee, H. H., on hand-picking as remedy for Potato Bugs, IV, 11
McCartney, Jno. P., on White Grub, I, 156
McNallie, Thomas, on Rocky Mountain Locust, IX, 72
Meador, W. R., on Rocky Mountain Locust, IX, 75
Meadow Grasshopper, V, 123
Meal-worm, II, 10, 11, VI, 118
Mealy Bug, V, 80
Meat-flies, II, 19, VII, 27
Meeker, N. C., on Rocky Mountain Locust, VIII, 84
Megarthus, IV, 22
Megathymus yuccæ, VIII, 169, 171, 179, IX, 129
Megilla, Supp., 52
melancholica, *Euryomia*, III, 6
Melanerpus erythrocephalus, VIII, 124
melanocephala, *Pimpla*, III, 129
Melanoplus, VII, 188
melanosus, *Micropus*, VII, 22
melanothorax, *Doryphora*, VIII, 10
Melanotus communis, III, 6
 incertus, III, 6
mellonella, *Galleria*, Supp., 57
melodia, *Melospiza*, VI, 27
Meloe, VI, 125
Melospiza melodia, VI, 27
melpomene, *Heliconius*, III, 173
melsheimeri, *Perophora*, V, 125
Membracidae, a family of Homoptera, V, 123
Membrane-winged Flies, an Order of Insecta, V, 9
Meracantha contracta, VI, 118
Merohant, J. W., on Oyster-shell Bark-louse, V, 77
Merchants' Exchange, (St. Louis) relief committee from, VIII, 93
merdigera, *Crioceris*, II, 58
Merdigerous habit in insects, II, 58, VI, 128
Mermis, V, 49
Meromyza americana, I, 159
Merritt's Patent Tree-protector, II, 99
Meske, Otto, on Army Worm, VIII, 44
Mesochorus fuscipennis, VII, 75
 vitreus, II, 52, VIII, 53
messoria, *Agrotis*, Supp., 77
Metagenetic Coccids, V, 64
Metzler, T., on grape culture, VI, 83
Microcentrus retinervis, VI, 155, 156
Microgaster, I, 89, II, 75, 102, III, 158, IV, 43, V, 138
 VIII, 54, Supp., 66
 aeronyctus, II, 120
 glechiae, I, 178, Supp., 66
 glomeratus, III, 167
 limitidos, III, 158, Supp., 66
 militaris, I, 89, II, 52, VIII, 53, Supp., 53
Micropteryx, III, 7
 pomivorella, III, 7
Micropus leucopterus, II, 15, VII, 19, Supp., 58
 var. *albivenosus*, VII, 22
 apterus, VII, 22
 basalis, VII, 22
 dimidiatus, VII, 22
 femoratus, VII, 22
 fulvivenosus, VII, 22
 immarginatus, VII, 22
 melanosus, VII, 22
 nigricornis, VII, 22
 rustipis, VII, 22
Migration of butterflies, III, 152
 locusts, conditions of, VIII, 112
migratoria, *Edipoda*, VII, 133, VIII, 145
migratorius, *Turdus*, VI, 27
Migratory Locust, VII, 133
milberti, *Proctacanthus*, Supp., 88
militaris, *Exorista*, II, 50, III, 129, IV, 109
 Microgaster, I, 89, II, 52, VIII, 53, Supp., 53

- militaris*, *Senometopia*, II, 50
 Military Microgaster, II, 52, 103, VIII, 53
 Miller, J. B., on Strawberry Crown-borer, III, 42
 Miller, Samuel, on grape culture, VI, 76, 84
 on Locusts, VIII, 154
 Miller, Stephens, on Rocky Mountain Locust, IX, 92
 Miller, W. H., on Rocky Mountain Locust, VIII, 112
 Milliken, R. M., on Canker Worm Trap, VI, 25
 Milliken, R., on Rocky Mountain Locust, VII, 150, IX, 65
 Mimetic analogies, III, 163
 resemblance, V, 147
 Mimicry in animals, III, 159
 butterflies, III, 159
Mimus carolinensis, VI, 27, VIII, 124
minimus, *Empidonax*, VI, 27
 Pezomachus, II, 52, VIII, 54
ministra, *Datana*, III, 124, 127, 129, IV, 129
minuta, *Eupsalis*, VI, 113, 117
 Trichogramma, III, 158, Supp., 68
 Minnesota, act for the destruction of Locusts, IX, 113
 Legislation regarding Locusts, IX, 114
 Locust Commission, VIII, 83
 Locust history in, VIII, 81, IX, 60
 Locust invasion of 1876 in, IX, 60
mirabilis, *Antigaster*, VI, 162, Supp., 52
 Mirror and Farmer, article from, on Locusts, VII, 172
misella, *Chrysobothris*, VII, 71
missippus, *Limenitis*, III, 167, VI, 145
 Misnamed Gall-moth, II, 134
 Mississippi, Locust flights east of the, IX, 81
 Missouri, act to encourage the destruction of Locusts, IX, 111
 Democrat, article from, on Army Worm, VIII, 50
 Legislation regarding Locusts, IX, 112
 Locusts in, VIII, 89, 90, IX, 66
 Silk-growing in, IV, 83
 Missouri Bee-killer, II, 121, 122, IV, 21
missouriensis, *Asilus*, II, 121, 122, IV, 21, Supp., 87
 Mitchell, Th., on Army Worm, VIII, 39
 Mite, the Locust, VII, 175
 The Mussel-shaped, VII, 106
 The Phylloxera, VII, 106
 The Silky, VII, 175
 Mites, V, 87
 transformation of, VI, 52, 53
modesta, *Arna*, V, 133
 Modest Soldier-bug, V, 133
 Modrel, M. L., on Rocky Mountain Locust, IX, 75, 76
molesta, *Myrmica*, II, 11, IX, 43
molitor, *Tenebrio*, II, 9, 10, VI, 118
 Mollusca, a branch of the Animal Kingdom, V, 6
Molobrus mali, III, 6
molochinus, *Quedius*, IV, 21
Molothrus pecoris, VI, 27
 Molts, mode of enumerating larval, III, 145
Monoleuca semifascia, V, 126
 Monomera, a division of Heteroptera, V, 13
 Montana, Locust history in, VIII, 87, IX, 59
 Montgomery, G. W., on Rocky Mountain Locust, IX, 70
mori, *Bombyx*, IV, 74, 75, 84, 138
 Sericaria, IV, 75
 Mormon Louse, II, 17
 Morris, Rev. Dr. J. G., on Periodical Cicada, IV, 31
 Mortality among Grapevines, V, 58
 Mosquito, V, 13
 Mosquito Hawks destroying Army Worm moths, II, 46
 Moths, a section of Lepidoptera, V, 12
 Motsinger, J. L., on Rocky Mountain Locust, IX, 73
 Mottled Tortoise-beetle, II, 60, 63
 Moulton, J. T., jr., on Chinch Bug, VII, 33
 Muench, Hon. F., on Grape mortality, V, 58
 Muhleman, J. R., on Chinch Bug, VII, 34
 on Fall Web-worm, III, 131
 on Mimicry in Insects, III, 160
 on Raspberry Root-borer, VI, 11
 Mulberry Silk-worm, IV, 75, 114, 134, IX, 18
 Best food for, IV, 100
 Best varieties or races, IV, 91
 Choking the chrysalis, IV, 96
 Chrysalis of, IV, 87
 Cocoon, IV, 87
 Cocoonery, IV, 96
 Culture in California, IV, 79
 Kansas, IV, 82
 Missouri, IV, 83
 Egg, IV, 86
 Egg-laying, IV, 97
 Enemies and diseases, IV, 87
 How best to rear, IV, 92
 Its history in America, IV, 77
 Its past history, IV, 75
 Larva, IV, 86
 Moth, IV, 87
 Natural history, IV, 84
 Ossage orange as food for, IV, 100
 Reeling, IV, 98
 Mulsant, E., insect pins used by, V, 35
munda, *Occinella*, II, 25, VII, 39, Supp., 52
 Murgantia, IV, 35
 Munger, H. A., on Tile-horned Prionus, II, 90
murænula, *Agrotis*, I, 78
murcinaculata, *Calena*, Supp., 54
Murgantia histrionica, IV, 35
 munda, IV, 35
 Muriate of lime, Gould's, as a remedy for Canker Worm, II, 100
murina, *Fidia*, Supp., 53
 Lytta, I, 98, Supp., 54
 Murky Ground-beetle, I, 98, 115
 Murray, A., on Protective Mimicry, III, 170
 Murtfeldt, Miss M. E., on Oviposition of Narrow-winged Katydid, VI, 165
Musca bifasciata, V, 140
 domestica, II, 10
 Muscardine, a disease of Silkworms, IV, 88
Muscidae, III, 150, VII, 175
 Mussel-shaped Bark-louse, I, 15
 Mite, VII, 106
muticus, *Scolytus*, V, 105, 107
Myiarchus crinitus, VIII, 124

- Myelois convolutella*, Supp., 57
indiginella, IV, 38
suavella, Supp., 79
- Mygale*, IX, 98
Hentzii, II, 106
- Mygatt, E. G., on Remedies for Bark-lice, I, 18
- Myiodioctes canadensis*, VI, 27
- mylitta*, *Attacus*, IV, 138
- Myobia*, VI, 52
- Myocoryna 10-lineata*, VII, 16
- Myriapoda, a class of Articulate animals, V, 6
- Myrmica molesta*, II, 11, IX, 43
- myron*, *Darapsa*, II, 71
- Otus*, II, 71
- Sphinx*, II, 71
- Myria 15-punctata*, IV, 18, Supp., 53
- Mytilaspis canchiformis*, V, 93
linearis, V, 93
pini, V, 98
pinifoliae, V, 97
pomicorticis, V, 73, 95, Supp., 85
pomorum, V, 93, 94
- N.
- nana*, *Trogosita*, III, 6
- napt*, *Ceutorhynchus*, III, 11
- Narrow-winged Katydid, V, 124, VI, 164
 Descriptions of adolescent stages, VI, 166
 Oviposition, VI, 165
- Nashville Warbler destroying Canker Worm, VI, 27
- nasicornis*, *Oryctes*, VI, 124
- National Agricultural Congress, Address before, VI, 17
- National Academy of Sciences, proposed Entomological Commission under, VII, V
- Native American Onion-fly, II, 9
- Native Currant Worm, IX, 23
 Descriptive, IX, 28
 Its habits, IX, 24
 Remedies, IX, 28
 Wherein it differs from the imported species, IX, 23
- Native home of the Colorado Potato-beetle, VIII, 8
 Rocky Mountain Locust, VIII, 109
- Natural selection, remarks on, III, 159, IV, 84, V, 83
- Naturaliste Canadien*, article from, on Polyphemus Silk-worm, IV, 128
- Nazara*, IV, 20
- Neat Cucumber Moth, II, 88
- Nebraska Bee-killer, I, 168, II, 122, IV, 2
 , Locusts in, VIII, 79, IX, 64
- nebris*, *Gortyna*, Supp., 56
- nebulella*, *Acrobasis*, IV, 42, Supp., 80
- nebulos*, *Acrobasis*, IV, 38, 47, Supp., 79
Phycita, III, 7, IV, 38, 41, Supp., 79
- Necrobia ruficollis*, VI, 101
- Necrophaga, a division of Coleoptera, V, 11
- Necrophoridae*, III, 14
- Needham, H. V., on Chinch Bug ravages, VII, 37
- Negro-bug, II, 35
 Flea-like, VII, 48
- Nematus*, Supp., 59
affinis, IX, 7
grossulariae, IX, 7
grossulariatus, IX, 7
- Nematus, ribesii*, IX, 7
salicis-pomum, IX, 20
trinaculatus, IX, 7
ventricosus, VI, 43, 149, IX, 7, 10, 21
- Nemocera, a section of Diptera, V, 13
- Nemoreia*, V, 140, Supp., 60
- memorum*, *Hattica*, I, 101
Phyllotreta, III, 83
- Nemotois scabrosellus*, V, 160
- nenuphar*, *Conotrachelus*, I, 50, III, 11, 28, 31, 127, Supp., 54, 65, 68
- Nerve-winged insects, V, 14
- Neuroptera, characteristics and classification of, V, 14
- neustria*, *Clisiocampa*, III, 119
- New England Farmer*, article from, on Potato-bug in Massachusetts, IV, 8
- Grape-root Borer, II, 87
- York Tribune*, article from, on Clover Worm, VI, 104
 article from, on Grape Phylloxera, VI, 85, VII, 94
 article from, on grape-vine grafting, VII, 109
 article from, on Potato-beetle, IX, 35
 article from, on remedy for Canker Worm, II, 101
 article from, on Rocky Mountain Locust, VII, 189, VIII, 156, IX, 64
- York Weevil, III, 6, 57
- ni*, *Plusia*, II, 112, Supp., 78
- niger*, *Gryllus*, VI, 152
- nigricans*, *Agrotis*, I, 81, 83, 87
- nigricornis*, *Micropus*, VII, 22
Ecanthus, Supp., 61
- nigripes*, *Ossida*, II, 63, Supp., 63
- Nine-spotted Lady-bird, I, 112
- Nisoniades juvenalis*, III, 155, VIII, 177
- Nitoby, F. A., on Fall Army-worm, III, 109
- nitela*, *Gortyna*, I, 92, III, 105, VII, 37, Supp., 56
- nitidalis*, *Phacellura*, II, 7, 64, 68
- niveus*, *Ecanthus*, I, 138, V, 120, Supp., 60, 61
- Noctua clandestina*, I, 79, Supp., 55
unipuncta, II, 49, VIII, 34
- Noctuidae* II, 45, III, 136
- Nomenclature, II, 71, III, 94, 133, 143, IV, 55, VI, 109, 150, 153, VII, 16, 89, 143, 187, VIII, 22, 179, IX, 50
- Need of popular terms that will not confuse, VI, 153, VII, 187
- Law of priority, IV, 53, VII, 143, VIII, 179, IX, 7
- Popular vs. scientific names, VII, 187
- Nonagria*, VIII, 38
- Northern Army-worm, VIII, 24
 Benthian, VI, 113
- Northern Squash-beetle, IV, 18
- Nothrus ovivorus*, II, 102
- novaboracensis*, *Ithycerus*, III, 6, 57
- novem-notata*, *Coccinella*, I, 112
- Noxious Insects, I, 7, IV, 72, V, 46
 How to counterwork, V, 23
- nucum*, *Balaninus*, III, 11
- nuncius*, *Cryptus*, IV, 110, 111, 123, Supp., 52
- Nycteribide*, V, 14
- Nymphalidae*, III, 167, VI, 138
- Nymphalis disippus*, II, 125

- Nysius angustatus*, V, 113, Supp., 85
destructor, V, 111, 113, VII, 190, Supp., 84, 85
raphanus, V, 111
thymi, V, 113, Supp., 85
- .
- Oak-feeding Tortricid, VI, 103
Oak Phylloxera, the American, VI, 64, VII, 118
Oak-pruner, I, 25
Oarisma pmoschick, VIII, 178
Oberca ocellata, I, 178, 179
perpicillata, VI, 111
obesa, *Amara*, Supp., 52
oblinita, *Acronycta*, III, 70, 71
oblineatus, *Capsus*, II, 113, VII, 27
oblonga, *Celana*, III, 136, Supp., 75
oblongifolia, *Phylloptera*, II, 57, VI, 169
Oblong-winged Katydid, II, 57, V, 123, VI, 169
obscura, *Prodenia*, III, 117
Ohrysobothris, VII, 71
Laphygma, VIII, 49
obscurus, *Prionus*, I, 127
Tenebrio, II, 9, 11
obsoletus, *Bruchus*, III, 54, 56, Supp., 70, 71
occidentalis, *Acronycta*, II, 121, Supp., 73
Caloptenus, VIII, 116
ocellata, *Oberca*, I, 178, 179
octomaculata, *Alypia*, I, 136, II, 80, 82, VI, 88, 94, 95
oculana, *Grapholitha*, III, 6
Oecanthus bipunctatus, Supp., 61
californica, Supp., 61
fasciatus, Supp., 60
latipennis, Supp., 60, 61, 62
nigricornis, Supp., 61
niveus, I, 138, V, 120, Supp., 60, 61
varicornis, Supp., 61
Oedipoda, VIII, 103, 128
atrox, VII, 124
carolina, VII, 175, 179
differentialis, V, 14
migratoria, VII, 133, VIII, 145
phaenicoptera, VIII, 104
Oestrus, III, 150
ovis, I, 161
Oeta compta, I, 151, Supp., 58
Eggs of, Supp., 58
Oil of cade as remedy for Grape Phylloxera, IV, 68
olens, *Goerius*, IV, 21
oleracea, *Pieris*, II, 105
olinatis, *Asopia*, VI, 103, 107
olivaceus, *Vireo*, VI, 27, VIII, 125
Omaha Bee, article from, on Rocky Mountain Locust, VIII, 80
Omaha Conference on the Locust subject, IX, 106
Oncideres cingulatus, III, 6
Onion Fly, I, 155
-maggot, V, 13
opaoulus, *Lyctus*, IV, 54
Ophion, II, 130, IV, 123
bilineatus, III, 69
lateralis, II, 33
macrurum, IV, 107
purgatus, II, 53, VIII, 54
Ophion, the Long-tailed, IV, 129
Ophiura zylina, II, 40
Orchard Tent-caterpillar, III, 129
Orchelimum, VI, 155
glaberrimum, V, 123, Supp., 62
Orygia leucostigma, I, 144
Oribatida, VI, 54
orientalis, *Blatta*, II, 10
orizivora, *Dolichonyx*, VIII, 52
ornata, *Strachia*, IV, 38
Orocharis saltator, I, 138, V, 119, Supp., 60, 62
Eggs of, Supp., 62
Stridulation of, Supp., 62
Ortalis arcuata, II, 9
Orthia, VIII, 178
Orthoptera, characteristics and classification of, V, 14
Orthosoma cylindricum, I, 124, 127, II, 87
Orthotylus discoidalis, V, 154
Orton, Edward, on Legged Maple-borer, VI, 109
ortoni, *Agrotis*
Ortyx virginiana, II, 28, VII, 41
Oryctes nasicornis, VI, 124
oryzivorus, *Dolichonyx*, VI, 27, VIII, 52
Oscinis vastator, I, 161
Osborne, Gov., Proclamation of regarding Locust ravages, VII, 149
Osten-Sackenii, *Exorista*, II, 51
ostreaformis, *Diapsis*, Supp., 60
Otiorynchus sulcatus, III, 11
Otus enotus, II, 71
myron, II, 71
Ovipositor of *Æschna*, VIII, 36
Agriion, VIII, 36
Army Worm Moth, VIII, 32, 33, 38, 182
Canker-worm Moth, VIII, 37
Fall Army-worm, VIII, 37
Katydid, V, 154, VIII, 37
Plum Curculio, VIII, 36
Unarmed Rustic, VIII, 37
Yucca Moth, VIII, 37
ovis, *Oestrus*, I, 161
ovivorus, *Nothrus*, II, 102
Owlet Moth, II, 10, 45, 119
Oyster-shell Bark-louse, I, 7, II, 6, 10, 14, V, 26, 73, Supp., 86
Bibliographical and Descriptive, V, 91
Both single and double brooded, V, 79
Enemies and parasites, I, 16, V, 87
Food Plants, I, 15, V, 86
Formation of the scale, I, 12, V, 80
Its occurrence in Missouri, V, 74
Its range south, V, 77
Its spread westward, V, 79
Male Louse, V, 88
Mode of growth, I, 10
Mode of spreading, I, 15, V, 85
Remedies, I, 16, V, 90
Southern limits in Missouri, I, 8
True nature of the scale, V, 80
ozyococcana, *Teras*, Supp., 83
Tortrix, Supp., 83
Ozyptilus, Supp., 58
- P.
- Pachymerus vulnerator*, IV, 28
Pachyrhynchus Schenherri, III, 57
Packard's "Guide to the Study of Insects," V, 44

- Pœdisca afusana*, Supp., 57
 Painesville (Ohio) *Telegraph*, article from, on Potato-beetle, VI, 12, 13
 Painted Borer, III, 7
 Lady, III, 151
 Lady-bird, V, 101
 Mamestra, II, 118
 -winged Digger-wasp, V, 149
Palaeocrita—A new genus for the Spring Canker-worm, VIII, 13, Supp., 58
Palaeocrita vernata, VIII, 13
 Pale-thighed Tortoise-beetle, II, 62
Palingenia, IX, 128
pallida, *Cassida*, II, 62
 Palmer, R. B., on Oyster-shell Bark-louse, V, 77
 Palsen, W. D., on Chinch Bug, VII, 22
pakudana, *Tortrix*, VI, 103
pandorus, *Daphne*, II, 76
Pantocus geminatus, I, 89
pamplinatrix, *Ocherocampa*, II, 71
paphia, *Antheropa*, IV, 138
Paphia, V, 149, VI, 138
 glycerium, II, 125, 127, V, 145
Papilio, II, 117, V, 146
 asterias, III, 169
 philenor, II, 116, III, 169, Supp., 54
 troilus, III, 169
 turnus, VI, 145
Papilionidae, VI, 138
paradozus, *Rhipiphorus*, VI, 125
 Parallel Pruner, III, 6
parallalum, *Elaphidion*, III, 6, IV, 54
Parasa chloris, V, 126
 Parasites, artificial propagation of, III, 29, IV, 40, V, 90
 artificial introduction of, VII (preface, p. 4)
 of Abbot's White Pine Worm, IX, 81
 Archippus Butterfly, III, 149
 Army Worm, I, 89, II, 50, VIII, 53
 Bag-worm, I, 150
 Buck Moth, V, 138
 Cabbage Worm, II, 109
 Cecropia Worm, IV, 107
 Codling Moth, IV, 23, V, 49
 Colorado Potato-beetle, I, 111, IX, 40
 Common Yellow Bear, III, 69
 Cottonwood Dagger, II, 120
 Cut-worms, I, 69
 Disippus Butterfly, III, 157
 Flat-headed Borer, VII, 74
 Goatweed Butterfly, V, 149
 Gooseberry Span-worm, IX, 6
 Grape Curculio, I, 129
 Green-striped Maple Worm, V, 139
 Hickory Bark-borer, V, 106
 Hog-caterpillar of the Vine, II, 73
 Imported Currant Worm, IX, 17
 Io Moth, V, 136
 Katydid, VI, 162
 Lasioptera vitis, V, 118
 Luna Silkworm, IV, 125
 Oyster-shell Bark-louse, V, 87
 Pine-leaf Scale-insect, V, 100
 Plum Curculio, III, 24
 Polyphemus Silkworm, IV, 129
 Promethea Silkworm, IV, 123
 Parasites of Rascal Leaf-crumpler, IV, 40
 Rocky Mountain Locust, VII, 174, IX, 91
 Smeared Dagger, III, 71
 Solidago Gall Moth, I, 175
 Tawny Emperor Butterfly, VI, 142
 Walnut Case-bearer, IV, 43
 Wheat-head Army Worm, IX, 55
 White Grub, VI, 123
 White-lined Morning Sphinx, III, 142
 Yama-mai Silkworm, IV, 136
 Yucca Borer, VIII, 179
 Parasitism, VI, 123
 Secondary, VI, 128
 Paris Green, antidote for, IV, 13
 Contrivance for dusting, IV, 2
 Cost of application per acre, VIII, 3
 Experiments with, VIII, 6, 7
 for Canker Worm, VI, 26
 Colorado Potato-beetle, IV, 11, V, 53, VII, 8, VIII, 3
 Cotton Worm, VI, 17, VII, 9
 Curculio, III, 18
 Flat-headed Borer, VII, 78
 Locusts, VII, 183
 Influence of, on man through the soil or through the plant, VII, 13
 Influence of, on the plant, VII, 11
 the soil, VII, 11, VIII, 6
 Machines for spraying, VI, 20, VII, 15, VIII, 4, 5
 Patents on, VI, 20
 Parker, Dr. S. J., on mortality among grape-vines, V, 59
 Parrish, W. S., on Rocky Mountain Locust, IX, 73
 Parthenogenesis, IV, 86, V, 85, VI, 35, IX, 18
Parula americana, VI, 27
Parus atricapillus, IV, 107, VI, 27
Parimachus elongatus, I, 115, VIII, 52, IX, 98
 punctulatus, IX, 98
Passalus cornutus, IV, 139, 140, V, 7, 55
 distinctus, IV, 141
 interruptus, IV, 141
Passalus, the Horned, IV, 139
 Patent remedies and nostrums, IV, 15
 Patents on insecticides, VI, 21
 Pauls, G., on Fall Army-worm, III, 111
 on Rocky Mountain Locust, VII, 173
 Payne, M. S., on Rocky Mountain Locust, VIII, 69
 Payne S. D., on Rocky Mountain Locust, VIII, 123
 on Enemies of Rocky Mountain Locust, IX, 96
 Pea Bug, II, 11, III, 45
 Pea-weevil, III, 44, 55, IX, 43
 The female deposits her eggs on the outside of the pod, III, 46
 Remedies, III, 48
 Peach Borer, I, 47, II, 11, III, 76, 77, VI, 108
 Remedies for, I, 48
 Peach-worm, the Blue-spangled, III, 132
 Pear Blight, III, 58
 Pear-tree Flea-louse, II, 10
 Pearl Wood Nymph, II, 80, 83, 84, III, 63, VI, 90
Pèbrine, a disease of Silkworms, IV, 88, 89, 90, 91
 Peck, W. D., on Canker Worm, VII, 89
 Pecks' Spray Machine, VIII, 4

- pecoris*, *Molothrus*, VI, 27
pectinatus, *Rhipiphorus*, VI, 125
Pelidnota punctata, III, 77, 78
pellionella, *Tinea*, II, 10
Polopæus, V, 157
Pempelia, IV, 46
 grossulariæ, I, 140, II, 9, Supp., 57
 hammondi, IV, 44, 46, Supp., 80
Pemphigus, III, 96
 caryæcaulis, VII, 117
 caryæcenæ, VII, 117
 imbricator, I, 121
 vagabundus, I, 112, 120, VII, 97
 vitifoliæ, I, 13, III, 85, 93, VI, 31, VII, 94, 117
Pendleton, E. M., on Rocky Mountain Locust, IX, 85
Pennsylvania Ground-beetle, I, 59, IX, 98
 Soldier-beetle, IV, 28
 -bug, I, 57
pennsylvanicæ, *Dendroica*, VI, 27
 Epicauta, Supp., 54
pennsylvanicus, *Chauliognathus*, I, 57, IV, 28, Supp., 53
 Harpalus, I, 59, VIII, 52
Pentamera, a section of Coleoptera, V, 10
Pentarthron, Supp., 69
Pentarthrum, Supp., 69
Pentatoma rufipes, IV, 20
Penthina vitivorana, I, 123, Supp., 57
Pepis formosa, II, 106
peregrinum, *Acridium*, VII, 133, VIII, 144, 145
Perilampus platygaster, II, 87
Perilitus indagator, IV, 43, Supp., 66
Perillus circumscriptus, IV, 19
Periodical Cicada, I, 18, III, 6, IV, 30
 Chronological history, with predictions of the future appearance of broods, I, 30
 Enemies, I, 26
 Injury, to fruit trees, I, 29
 Natural history and transformation, I, 22
 Season of appearance and disappearance, I, 22
 17- and 13-year broods, I, 18
 Sting of, I, 26
 Two distinct forms, I, 20
perisotidactylus, *Pterophorus*, I, 137, III, 65, Supp., 68
Peritymbia vitisana, IV, 55, VI, 31, VII, 117
Perkins, Geo. H., on Colorado Potato-beetle, VIII, 2
Perla, V, 143
pernyi, *Antheræa*, IV, 137
 Attacus, IV, 74, 137, 138
Perny's Silkworm, IV, 137
Periphora Melshineri, V, 125
perpulchra, *Hockeria*, II, 53
persimilata, *Acidalia*, VI, 138
Perthostoma, IX, 129
Peterson, J. M., on Rocky Mountain Locust, IX, 73
Pezomachus minimus, II, 52, VIII, 54
Pezotettix, VIII, 115
Phacellura nitidalis, II, 7, 64, 68
Phalæna frugiperda, VIII, 48
 punctella, Supp., 58
 vernata, VII, 80
Phalænida, description of a new genus of, VIII, 12
phalanga, *Catocala*, III, 166
Phalangium dorsetum, IV, 17
Phaneroptera curriculauda, V, 124, VI, 164
Phares, Dr. D. L., on Cotton Worm, II, 38, 40, VI, 24
Phelps, Wilson, on Remedy for Chinch Bug, II, 29
Philampelus achemon, II, 74
 satellitica, II, 76
philenor, *Papilio*, II, 116, III, 169, Supp., 54
Philenor Swallow-tail, II, 116, III, 169
Philonthus apicalis, IV, 21
Phobetrion hyalinum, V, 126
 pthiticium, V, 126
phœniceus, *Agelaius*, VI, 27
phœnicoptera, *Edipoda*, VIII, 104
Pholus orantor, II, 74
 lycaon, II, 76
Phoxopteris comptana, Supp., 57
Phryganæida, V, 10
Phtheir, VI, 63
Phycis grossulariella, Supp., 57
Phycita juglandis, Supp., 80
 nebulosa, III, 7, IV, 38, 41, Supp., 79, 80
 var. *nebulosa*, IV, 42, Supp., 80
phycita, *Exorista*, IV, 40, Supp., 88
 Tachina, IV, 40, Supp., 88
Phygadeuon brevis, IV, 28
Phylloptera oblongifolia, II, 57, V, 123, VI, 169
Phyllotreta nemorum, III, 83
 striolata, III, 83
Phyllozera acanthochermes, VII, 119
 balbanti, VII, 91, 97, 99, 119
 caryæcaulis, VII, 97, 99, 117
 caryæfoliæ, IV, 66, V, 70, VI, 45, VII, 117
 caryæfallax, VII, 118
 caryæglobuli, VII, 117
 caryægummosa, VII, 118
 caryæren, VII, 118
 caryæsemen, VII, 117
 caryæsepta, VII, 118
 castanea, VII, 118
 coccinea, VII, 119
 conica, VII, 118
 corticis, VII, 119
 depressa, VII, 118
 forcata, VII, 118
 gallicola, VI, 30, 33, VII, 93
 lichtensteini, VII, 119
 quercus, IV, 66, VI, 30, 41, 43, 68, VII, 91, 119, VIII, 158
 radicicola, VI, 33, 36, 37, VII, 93
 rileyi, IV, 68, VI, 42, 43, 64, 86, VII, 91, 117, 118, VIII, 158
 scutifera, VII, 119
 spinosa, VII, 118
 vastatrix, III, 85, IV, 55, V, 57, VI, 30, 63, 66, 86, 87, VII, 91, 117, VIII, 157
 vitifolia, II, 27, III, 84, IV, 55
 Position of the genus in the system, III, 96
 Synopsis of the American species of, VII, 117
Phylloxera, American Oak, VI, 64, VII, 99, 118
 European Oak, VI, 46, 64
 Grape, III, 84, IV, 55, 67, V, 57, 63, VI, 41, 90, VIII, 157, IX, 43
Phylloxera, Mite, VII, 106
phylloxera, *Thrips*, VI, 50
 Tyroglyphus, VI, 52, 53, 61

- Physonota quinquepunctata*, II, 59, Supp., 53
unipunctata, Supp., 53
Phytocoris linearis, II, 113
 Phytophaga, a division of Coleoptera, V, 11
 Terebrantine Hymenoptera, V, 10
 Phytophagic varieties and species, I, 151, III, 127
 Pickle Worm, II, 7, 64, 67, 70
picta, *Coccinella*, V, 101, Supp., 52
 Harmonia, Supp., 52
 Mamestra, II, 112
pictus, *Olytus*, III, 7, VI, 101
Pieris, III, 161
 brassicae, III, 167
 oleracea, II, 105
 protodice, II, 104, IX, 57
 rapae, II, 10, 107, III, 167, V, 24, 26, VII, 5
 vernata, IX, 57
Piesma cinerea, II, 32, VII, 47
Pimpla, I, 178, III, 129, IV, 44
 annulipes, IV, 43, V, 49
 conquisitor, IV, 43
 indagatrix, IV, 43
 melanocephala, III, 129
 Pine-leaf Scale, III, 92, V, 84, 97
 Confined to Pines proper, V, 100
 Its natural history, V, 98
 Natural enemies, V, 100
 Remedies, V, 101
 Two-brooded, V, 99
 Pine Worm, Le Conte's, IX, 32
pinifoliae, *Aspidiotus*, III, 92
 Mytilaspis, V, 97
pini, *Mytilaspis*, V, 98
Pioneer Press and Tribune, article from, on Rocky Mountain Locust, IX, 61
Piophilæ casei, II, 10
Pipiza radicum, I, 121, VI, 52
Pirene, I, 176
pisi, *Bruchus*, II, 11, III, 44, Supp., 53
pisorum, *Bruchus*, Supp., 53, 71
Pisodes strobis, III, 60
 Placid Soldier-bug, IX, 17
 Plant-lice, III, 87, IV, 35, VI, 33
 Number of annual broods of, II, 19, VII, 27
Platte City Landmark, article from, on Rocky Mountain Locust, VIII, 74
Platygaster, II, 103
platygaster, *Perilampus*, II, 87
Platyphyllum concavum, V, 123, 124, VI, 167
Platyphylus castorinus, V, 16
Platyptilia, Supp., 84
 zetterstedtii, Supp., 84
Platysamia cecropia, IV, 103
Pleasant Hill Review, article from on Rocky Mountain Locust, VIII, 65
Plectrophanes lapponicus, IX, 91
plicata *Chlamys*, VI, 128
plorabunda, *Chrysopa*, II, 26, VI, 51, VII, 40
 Plum Curculio, I, 50, II, 6, 48, III, 5, 6, 11, 13, 26, 30, 37, 38, 57, 58, 127, V, 26, 47, 106, 121, VI, 9, VII, 29, VIII, 36
 Artificial Remedies, I, 60
 Hooten's Curculio-catcher, III, 23
 Hull's Curculio-catcher, III, 19
 Jarring by machinery, III, 18
 Plum Curculio—Continued.
 Keeping it in check by the offer of premiums, III, 17
 Natural Remedies, I, 56
 Nocturnal rather than diurnal, III, 14
 Paris green as a remedy, III, 18
 Porizon Curculio Parasite, III, 28
 Remedies, I, 60, III, 41
 Sigalphus Curculio Parasite, III, 24
 Single-brooded and hibernates as a beetle, III, 11
 The Ransom Chip-trap process, III, 15
 Ward's Curculio-catcher, III, 20
 Plum Gouger—Its character, distribution, II, 11, III, 39
 Habits and natural history, III, 40
 Its time of appearance, III, 40
 Often mistaken for the Plum Curculio, III, 40
 Remedies, III, 41
 Plum Moth, III, 6, 25, 26, V, 51
 Plum-weevil, III, 30, 31
 Plume, Grape-vine, I, 137, IV, 129
Plusia brassicae, II, 110, 111, Supp., 77, 78
 ni, II, 112, Supp., 78
 precatonia, II, 112
Plutella cruciferarum, II, 10, IV, 36
Podisus, Supp., 58
 placidus, IX, 17
Pœcloptera completa, I, 152
 pruinosa, V, 122
 Poisonous qualities of Colorado Potato-beetle, VIII, 10
polistiformis, *Egeria*, I, 127
Polistes rubiginosus, V, 54
 Pollen carried in thunder-showers, V, 86
Polyxerus cagurus, VII, 106
 Polson, W. D., on Rocky Mountain Locust, IX, 74
Polygramma, VII, 18
 10-lineata, VII, 16
 Polymorphism, VI, 43
polyphemus, *Attacus*, III, 170, IV, 13, 74, 85, 110, 121, 125, 138
 Telea, IV, 125
 Polyphemus Moth, II, 19, VII, 27
 Issuing of, from cocoon IV, 127
 Polyphemus Silkworm, IV, 125
 Food-plants, IV, 126
 Larval changes, IV, 126
 Natural enemies, IV, 126
 Natural history, IV, 125
 Parasites, IV, 129
 Value of silk, IV, 129
Polyphemina bicarinata, III, 71
pometaria, *Anisopteryx*, II, 97, VI, 29, VII, 80, 83, 88, VIII, 13, Supp., 56
pomicorticis, *Mytilaspis*, V, 73, 95, Supp., 85
pomisoliella, *Bucculatrix*, IV, 49, 51
pomivorella, *Micropteryx*, III, 7
pomonella, *Carpocapsa*, I, 62, 108, II, 10, III, 6, 101, IV, 27
 Trypeta, I, 108, III, 6, 91
pomorum, *Anthonomus*, III, 11
 Mytilaspis, V, 98, 94
 Poplar Dagger, II, 119
 Spinner, II, 19, VII, 27

- Popular names, confusion from improper use of, VII, 187
- populi*, *Acronycta*, II, 119, 120, Supp., 72, 74
- populnea*, *Saperda*, IV, 22
- Porizon conotrachei*, III, 28, Supp., 64
- Porizon Curculio Parasite*, III, 28
- Potash, Bichromate of, for Potato-bugs, IV, 14
- Potato-beetle (see Colorado Potato-beetle).
- Potato Bug (see Colorado Potato-beetle).
- Pest poison, VIII, 7, IX, 45
- Stalk-borer, I, 92
- Stalk-weevil, I, 93, III, 60
- worm, I, 95, V, 125
- Potherb Butterfly, II, 105
- Potts, R. B., on Rocky Mountain Locust, IX, 92
- Powers, Rev. Grant, on Northern Army-worm, II, 42
- Poweshiek*, *Oarisma*, VIII, 178
- Practical Entomologist*, article from, on Climbing Cut-worms, I, 71
article from, on Harlequin Cabbage Bug, IV, 36
- Prairie Farmer*, article from, on *Alanthi*-culture, IV, 114
article from, on Canker Worm trap, VI, 25
articles from, on Chinch Bug, II, 23, 30
article from, on Climbing Cut-worms, I, 89
article from, on Colorado Potato-beetle, I, 110
article from, on Dark-sided Cut-worm, I, 75
article from, on Food of Periodical Cicada, I, 29
article from, on Hickory Bark-borer, V, 105
article from, on Katydid, VI, 154
article from, on Lesser Leaf-folder, IV, 48
article from, on Locust Mite, VII, 177
article from, on Remedy for Potato-beetle, IV, 15, VIII, 3
article from, on Rocky Mountain Locust, VII, 135, 138
- Prairie Warbler* destroying Canker Worm, VI, 27
- Pratt, S. M., on enemies of Rocky Mountain Locust, IX, 93
- Prayers to avert insect injury, VIII, 96
- precautionis*, *Plusia*, II, 112
- Predictions verified, VII, 3, VIII, 58, 163, 184, IX, 57
- Preying Mantis, IX, 98
- Prionus imbricornis*, II, 89, III, 6, 75
laticollis, II, 87, III, 6, 75, V, 56
obscurus, I, 127
- Priority, law of, IV, 55, VII, 143, VIII, 179, IX, 7
- Pristiphora*, II, 8
grossularis, IX, 23, 26
- Pritchett, H. Carr, on Rocky Mountain Locust, IX, 75
- Processionary caterpillar, V, 126
- Proclamation of Governor Hardin relating to Locusts, VIII, 95
- Procris americana*, II, 85
vitia, II, 86
- Procris, the Grape-vine, V, 134
- Proctacanthus milbertii*, Supp., 88
- Proctotrupidae*, V, 118
- Prodenia autumnalis*, III, 109, 116, 151, IV, 129, VIII, 48
var. *fulvosa*, VIII, 49
obscura, VIII, 49
commelinæ, I, 88, III, 13, Supp., 56
flarinedia, Supp., 56
lineatella, Supp., 56
- Progress of Economic Entomology, V, 19
- Promachus*, Supp., 87
apivora, IX, 98
bastardii, II, 122, IV, 21, Supp., 60
fitchii, Supp., 60
vertebrata, II, 123
- promethea*, *Attacus*, IV, 74, 110, 121, 138
Callosamia, IV, 121, Supp., 55
- Promethea Silkworm, IV, 121
Foodplants, IV, 123
Larval changes, IV, 121
Natural enemies, IV, 123
Value of the cocoon, IV, 121
- Pronuba*, V, 150
yuccasella, V, 151, 160, VI, 131, VIII, 171, Supp., 58
Chrysalis of, VI, 131
Generic characters of, V, 150
How the female fertilizes the plant, V, 154
Larva of, V, 155
Range of, V, 159
- proserpina*, *Apatura*, VI, 145
Limenitis, III, 171
- Protective imitation, III, 142
- protodice*, *Pieris*, II, 104
- Provancher, Abbé, on parasite of Cabbage Worm, II, 110
on Polyphemus Silkworm, IV, 128
- pruinosa*, Cicada, I, 27
- Pruner, III, 6
- prunicida*, *Anthonomus*, III, 39, Supp., 54
- prunivora*, *Semasia*, I, 65, III, 6, 25
- Pseudohazis eglanterina*, V, 126
- Pseudo-Neuroptera, a division of Neuroptera, V, 14
- Pseudo-Tetramera, a section of Coleoptera, V, 10
- Pseudo-Trimera, a section of Coleoptera, V, 10
- Pseudopontia*, VIII, 170
- psi*, *Acronycta*, II, 121, Supp., 73
- Psoci* as museum pests, V, 41
- Psyche*, article from, on Rocky Mountain Locust, VIII, 109
- Psychomorpha epimenis*, III, 63, 64, VI, 87, 88, 90, 95
- Psylla pyri*, II, 10, 33
- Pterognostic variation, IX, 22
- Pterophorus*, II, 86
cardui, Supp., 83
carduidactylus, I, 180, III, 67
pericelidactylus, I, 137, III, 63, Supp., 58
- Ptinidæ*, IV, 53
- pubescens*, *Haltica*, I, 101
- pulchellus*, *Sphenophorus*, III, 60
- pulicaria*, *Corimelana*, II, 33, VII, 48

- Pulicidae*, V, 15
pullatus, *Ichneumon*, III, 69
 Pullen, B., on Flea-like Negro-bug, II, 34
 on remedy for Peach Borer, I, 48, 34
punctata, *Hyphantria*, Supp., 55
 Pelidnota, III, 77, 78
punctella, *Phatæna*, Supp., 58
punctipes, *Euschistus*, I, 113, IV, 19, 20, Supp., 58
 Pupation of Butterflies, III, 146, IV, 55, VI, 138, VIII, 179, Supp., 55
purgatus, *Ophion*, II, 53, VIII, 54
 Purged Ophion, II, 53, VIII, 54
 Purinton, J. A., on Rocky Mountain Locust, IX, 75
 Purple Emperor Butterfly, VI, 136
 Purple-finch unjustly accused of doing injury, I, 72
 destroying Canker Worms, VI, 27
 Purple Grackle destroying Canker Worm, VI, 28
purpureus, *Carpodacus*, VI, 27
pusilla, *Rhizopertha*, II, 14
pustulella, *Tinea*, Supp., 58
pustulosus, *Sphenophorus*, Supp., 54
 Putnam, J. D., on Rocky Mountain Locust, VII, 141
Pyramis atalanta, III, 167
 Pyramidal Grape-vine Worm, III, 72
pyramidea, *Amphipyra*, III, 73, 74
pyramidoides, *Amphipyra*, III, 72, 74, Supp., 75
Pyranga rubra, VI, 27
pyri, *Anthonomus*, III, 11
 Eriosoma, I, 118, III, 5, 95, 96, VI, 37, Supp., 59, 87
 Psylla, II, 10, 33
Pyrrharctia, Supp., 55
- Q.**
- quadrigibbus*, *Anthonomus*, III, 29, 35
quadri-impressa, *Chrysobothris*, VII, 71
quadripinosus, *Scolytus*, V, 105, 107, Supp., 54
 Quail destroying Chinch Bugs, VII, 41
 Locust eggs, IX, 91
 unjustly accused of being injurious, I, 72
Quedius molochinus, IV, 21
quercina, *Lachnosterna*, I, 67, 157, II, 19, VI, 123, VII, 27, Supp., 53
quercus-aciculata, *Cynips*, Supp., 50
 frondosa (Gall), III, 25
 inania, *Cynips*, I, 14
 spongifica, *Cynips*, I, 14
quercus, *Phylloxera*, IV, 66, VI, 30, 41, 43, 68, VII, 91, 119, VIII, 158
 Quick, T. J., on Rocky Mountain Locust, IX, 71
 Quince Curculio, III, 35
 How it differs from the others, III, 35
 Its transformations and habits, III, 37
 Remedies, III, 38
quindecim-punctata, *Mysis*, IV, 18, Supp., 53
quinque-maculata, *Sphinx*, I, 95
quinquepunctata, *Physonota*, II, 59, Supp., 53
Quiscalus versicolor, VIII, 124
- R.**
- Radiata*, a branch of the animal kingdom, V, 6
Radicicola or Root-inhabiting type of *Phylloxera*, VI, 36, 37, 38, 66, VII, 93
radicum, *Anthonymia*, IX, 92
 Pipiza, I, 121, VI, 52
Rhodites, I, 13

- rafflesia*, *Euschemon*, VIII, 170
 Ragan, Z. F., on Rocky Mountain Locust, VIII, 70, 105
 Ralla, Wm. C., on Rocky Mountain Locust, IX, 117
 Randolph, T. C., on Clover-hay Worm, VI, 103
 Ransom's Chip-trap for Curculio, III, 15
rape, *Pieris*, II, 10, 107, III, 167, VII, 5
Rapacious Soldier-bug, I, 114
Rape Butterfly, II, 10, 107, V, 24, VII, 5
Raphigaster, IV, 20
Raptatoria, a section of Orthoptera, V, 14
raptatorius, *Reduvius*, I, 114, Supp., 58
Rascal Leaf-crumpler, IV, 38, 42, 44, VII, 81
 Natural enemies of, IV, 40
 Remedies for, IV, 40
Raspberry Geometer, I, 139
 Root-borer, VI, 111
 Rathvon, S. S., on American Bean-weevil, III, 53
 on Colorado Potato-beetle, IX, 35
 on Periodical Cicada, I, 20, 22, IV, 81
 Ravenel, H. W., on Grape Phylloxera, VI, 83, VII, 102, VIII, 164, 165
 Raymond, H. C., on Rocky Mountain Locust, IX, 118
 Read, M. C., on Grape-vine Plume, III, 67
 Rearhorse, I, 169
Reason vs. instinct, V, 83, 15.
 Reavis, D. B., on Rocky Mountain Locust, IX, 73
rectus, *Balaninus*, IV, 144
 Red Currant Borer, II, 10
 Red-eyed Vireo destroying Canker Worm, VI, 27
 Locusts, VIII, 124
 Woodpecker destroying Locusts, VIII, 124
 -legged Ham-beetle, VI, 96
 Locust, VII, 125, 188, VIII, 150
 -shouldered Sinoxylon, II, 53, V, 54
 -tailed Tachina-fly, II, 50, III, 129, VI, 96, VII, 179, VIII, 53
 -start destroying Canker Worm, VI, 27
Reduvius, II, 32
 raptatorius, I, 114, Supp., 58
 Red Weevil, II, 16, IX, 17
 Red-winged Blackbird destroying Canker Worm, VI, 27
 Chinch Bug, VII, 41
 Reed, E. B., experiments with various substances for Potato-bugs, IV, 14
regalis, *Citheronia*, III, 151, IV, 129, V, 141
 Relation of Insects to Agriculture, V, 5, 18
 Relaxing Insects, V, 41
 Remedies, V, 25
 for Abbot's White Pine Worm, IX, 32
 Ailanthus Worm, I, 152
 American Meromyza, I, 161
 Apple Curculio, III, 34
 -leaf Bucculatrix, IV, 50
 Skeletonizer, IV, 45
 -root Plant-louse, I, 123
 -tree Tent-caterpillar, III, 120
 -twig Borer, IV, 53
 Army Worm, II, 53, VIII, 54
 Bag-worm, I, 151
 Bee-killer, I, 168
 Moth, I, 167

Remedies for Blister-beetles, I, 99

- Blue Caterpillars of the Vine, II, 84
- Boll Worm, III, 108
- Cabbage Plusia, II, 111
 - Worms, II, 109
- Canker Worms, II, 98, VI, 24, VII, 85, VIII, 19
- Chinch Bug, II, 28, VII, 31
- Clover-hay Worm, VI, 105
- Codling Moth, I, 65, IV, 23, V, 46, VI, 9
- Colorado Potato-beetle, I, 116, III, 99, IV, 11, V, 53, VI, 13, VII, 8, VIII, 3, IX, 45
- Corn Worm, III, 108
- Cotton Worm, II, 41, VI, 17
- Cut-worms, I, 90
- Fall Army Worm, III, 114
 - Web-worm, III, 132
- Flat-headed Borer, I, 47, VII, 76
- Flea-like Negro-bug, II, 35
- Gooseberry Fruit-worm, I, 141
 - Span-worm, IX, 6
- Grain Bruchus, III, 51
- Grape-cane Gall-curculio, I, 132
 - Leaf Folder, III, 62
 - Phylloxera, III, 89, IV, 68, V 71, VI, 55, VII, 105
 - root Borer, III, 77
 - vine Colaspis, III, 84
 - Fidia, I, 133
 - Flea-beetle, III, 80
 - Fruit-worm, I, 135
 - Plume, I, 138, III, 68
- Green-striped Maple Worm, V, 141
- Harlequin Cabbage-bug, IV, 38
- Hickory Bark-borer, V, 107
- Imported Currant Worm, IX, 13
- Jumping Sumach Beetle, VI, 121
- Legged Maple Borer, VI, 109
- Lesser Apple Leaf-folder, IV, 49
- Native Currant Worm, IX, 26
- New Grape-root Borer, I, 128, II, 88
- Oyster-shell Bark-louse, I, 16, V, 90
- Peach Borer, I, 48
- Pea-weevil, III, 48
- Periodical Cicada, I, 30
- Pickle Worm, II, 70
- Pine-leaf Scale-insect, V, 101
- Plum Curculio, I, 60, III, 15, V, 25
- Plum Gouger, III, 41
- Potato Stalk-borer, I, 92
 - weevil, I, 95
 - Worm, I, 96
- Pyramidal Grape-vine Worm, III, 73
- Quince Curculio, III, 38
- Rascal Leaf-crumpler, IV, 40
- Red-legged Ham-beetle, VI, 100
 - shouldered Sinoxylon, IV, 54
- Rocky Mountain Locust, VII, 181, VIII, 125, IX, 99, 108
- Rose Chafer, V, 110
- Round-headed Apple-tree Borer, I, 45
- Seed-corn Maggot, I, 155
- Sheep Bot-fly, I, 163
- Smeared Dagger, III, 70
- Strawberry Crown-borer, III, 43

Remedies for Strawberry Leaf-roller, I, 143

- Worm, IX, 28
- Striped Cucumber-beetle, II, 66
- Tarnished Plant-bug, II, 115
- Tent-caterpillar of the Forest, III 128
- Tile-horned Prionus, II, 90
- Tobacco Worm, V, 56
- Tortoise-beetles, II, 60
- Tree-cricket, I, 139
- Wheat-head Army Worm, IX, 54
- White Grub, I, 157
- White-marked Tussock Moth, I, 147
- Zebra Caterpillar, II, 113
- Remington, M. C., on Clover Hay Worm, VI, 104
- renigera*, *Calena*, I, 86, Supp., 56
- repanda*, *Cicindela*, VIII, 52
- repentis*, *Agrotis*, Supp., 77
- Report of Committee on Entomology, read before the Mo. State Horticultural Society, II, 5
- Retarded development, V, 130, 132
- retinervis*, *Microcentrus*, VI, 153
- Rhipheus*, VIII, 170
- Rhipiphorus paradoxus*, VI, 125
 - pectinatus* var. *ventralis*, VI, 125
- Rhizophis vastatrix*, VI, 31
- Rhizopertha pusilla*, II, 14
- Rhodites ignota*, I, 13
 - radicum*, I, 13
- Rhodobanus*, Supp., 54
- rhois*, *Blepharida*, I, 100, II, 58, VI, 118
- Rhopalocera a section of Lepidoptera, V, 12
- Rhynchites bacchus*, III, 11
 - detuloti*, III, 11
 - conicus*, III, 11
- Rhyparochromus devastator*, VII, 22
- Rhyssa*, VIII, 38
- ribesii*, *Aphis*, VI, 46
- ribis*, *Aphis*, II, 10
- Rice Bunting destroying Army Worm, VIII, 52
- Richmond *Conservator*, article from, on Rocky Mountain Locust, VIII, 75
- Richmond *Whig*, article from, on Apple grape-vine gall, V, 115
- ricini*, *Samia*, IV, 112
- Riehl, Wm., on Army Worm, VIII, 39
- rileyana*, *Tortrix*, I, 153, Supp., 81
- rileyi*, *Aleiodes*, III, 71
 - Eriosoma*, Supp., 87
- Phylloxera*, IV, 66, VI, 42, 43, 64, 86, VII, 91, 117, 118, VIII, 158
- Ring-banded Soldier-bug, IV, 18
- Ring-legged Pimply, V, 49
- Roberts, A., on Rocky Mountain Locust, IX, 117
- Robin destroying Canker Worm, VI, 27
- robiniae*, *Spermophagus*, III, 45
- roborana*, *Spilonota*, Supp., 57
- Robords, Chas. J., on Rocky Mountain Locust, IX, 69
- Robson, J. W., on birds destroying Canker Worms, VI, 27
 - on Rocky Mountain Locust, IX, 66, 91
 - on Wheat-head Army Worm, IX, 51
- Rocky Mountain Locust, VII, 121, VIII, 22, 57, IX, 57

Rocky Mountain Locust—Continued.

- Account of Damage done in Missouri, VIII, 89
- Additional Natural Enemies, IX, 91
- Animals which destroy the Eggs, IX, 91
- Area in which Eggs were laid in 1876, IX, 116
- Artificial Means of Destroying the Eggs, VIII, 125
- Bill to provide for investigation of, VIII, 133
- Bounties for catching and destroying Locusts, VIII, 138
- Changes that followed the Locusts, VIII, 121
- Chronological history, VII, 182
- Conditions of Migration, VII, 112
 - which prevent the permanent Settlement of the Species in Missouri, VIII, 118
- Contrast between Spring and Fall, during locust injury, VIII, 119
- Definition of the Species, VIII, 114
- Departing swarms do not return, VIII, 124
- Descriptive, VII, 126
- Destination of departing Swarms, VIII, 106, IX, 77
- Destitution in Missouri in 1876, VIII, 91
- Destruction of the unfledged young, VIII, 126, IX, 108
- Does the Female lay more than one egg-mass? IX, 85
- Direction of flight, IX, 81
- Direction in which young Locusts travel, VIII, 101
 - taken by winged Locusts, VIII, 105, IX, 81
- Easily confounded with the Red-Legged Locust, VII, 125
- Eastern line reached in 1876, IX, 80
- Egg-mass, philosophy of, IX, 87
- Eggs, condition of, in winter, IX, 116
 - description of, IX, 87
 - how laid, IX, 86
 - where laid by preference, VII, 123
 - experiments with, IX, 99
- Enemies and parasites, VII, 174, VIII, 124, IX, 91
- Exodus of the swarms in 1875, VIII, 104
- Experience in the Spring of 1875, VIII, 118
- Experiments with the Eggs, and conclusions drawn therefrom, IX, 99, 106
- Food-plants, VII, 158, VIII, 121
- General outlook in the Spring of 1875, VIII, 60
- Governor's Proclamation, VIII, 95
- Green variety of, VIII, 117.
- Habits of the unfledged Locusts, VIII, 100
- Hatching of Locusts, IX, 89
- How the young Locust escapes from the Egg, IX, 88
- How to avert Locust Injuries, VIII, 131
- Influence of burying the eggs at different depths, IX, 104
 - exposure to air on the eggs, IX, 104
 - freezing and thawing on the eggs, IX, 99
 - moisture on the eggs, IX, 101
 - wind in determining the course of Locust swarms, IX, 81

Rocky Mountain Locust—Continued.

- Injury from other, non-migratory Locusts, VII, 171
 - to fruit and fruit trees, VIII, 121
- Invasion of 1873, VII, 141
 - 1874, VII, 148
 - 1876, IX, 59
- Legislation, both national and local, VIII, 132
- Lessons of the year 1875, VIII, 142
- Locusts as food for Man, VIII, 143
- Measurements of *Caloptenus spretus*, VII, 130
- Migratory instinct and great destructive Power belong to but one species west of the Mississippi, VII, 124
- Native home, VII, 161, VIII, 109
- Natural enemies, VII, 174, VIII, 124, IX, 91
- Natural history, VII, 121, VIII, 97
- Not a divine Visitation, VIII, 97
- Not led by "Kings" and "Queens," VIII, 103
- Omaha Conference, IX, 106
- Outlook in Missouri in 1875, VIII, 61
- Predictions for 1875, VII, 166
- Previous experience in the Spring of 1867, VIII, 57
- Prospects in 1877, IX, 121
- Rate at which the young travel, VIII, 102
- Rate at which the insects spread, IX, 80
- Ravages, VII, 156
 - of migratory Locusts in the Atlantic States, VII, 167
- Reports of Correspondents, IX, 69, 117
- Source of Locust swarms of 1876, IX, 79
- Suggestions, VIII, 140
- Time of appearance, VII, 160
- Time of leaving of the winged insects, VIII, 104, 125
- Unnecessary alarm caused by native Locusts, VIII, 148
 - Wind, influence of, on flight, IX, 87
- Roe, J. E., on Rocky Mountain Locust, IX, 119
- Rogers, Dan F., on Chinoh Bug, II, 28
- Rogers, J. R., on Apple-tree Bark-louse, V, 78
- Root-borer of the Grape-vine, I, 124, II, 87, III, 75
 - Raspberry, VI, 111
 - Squash, II, 64
- Root-borers, III, 6
- Root-louse of the Grape-vine. (*See* Grape Phylloxera.)
- Root Plant-louse of the apple tree, I, 118, III, 5.
 - IV, 68, 69
 - Syrphus fly, I, 121
- Rope and tin band for Canker Worm, VI, 26, 27
- rosaceana*, *Loxotenidia*, III, 6
- rosee*, *Selandria*, II, 19, VII, 27
- rosee*, *Uroplata*, III, 6
- Rose-breasted Grosbeak destroying Potato-beetle, V, 54
- Rose-bug, III, 6
- Rose-bush Saw-fly, IX, 19
- Rose Chafer, V, 108
 - Hispa, III, 6
- Rose Leaf-roller, III, 6
- Rosy Dryocampa, V, 139
- Round-headed Apple-tree Borer, I, 45, II, 19, IV, 124, VII, 27

Round-headed Apple-tree Borer—Continued.

- Food plants, I, 43
 Natural history, I, 43
 Remedies, I, 45
- Rove-beetle*, larva of, IV, 21
Rove-beetles, habits of some, VI, 162
 Royall's Paris Green mixture, VI, 21
rubi, *Agria*, VI, 113, Supp., 72
Selandria, I, 52
rubicunda, *Anisota*, V, 140
Dryocampa, III, 123
rubivora, *Aplodes*, I, 139, Supp., 79
rubivoraria, *Synchlora*, Supp., 79
rubra, *Pyranga*, VI, 27
rustcapilla, *Helminthophaga*, VI, 27
rustcolis, *Necrobia*, VI, 101
rustmanus, *Bruchus*, III, 56, Supp., 70
rustpedis, *Micropus*, VII, 22
rustipes, *Corynetes*, VI, 101
Pentatoma, IV, 20
rufus, *Sigalphus*, III, 27, Supp., 68
 Rummaging Ground-beetle, II, 103, III, 129
Euptor ori, structure in many insect embryos, for bursting the egg-shell, IX, 127
Rural Carolinian, article from, on Locusts, VII, 173
Rural New Yorker, article from, on Apple-leaf Bucculatrix, IV, 50
 article from, on trapping Curculio, III, 16
Rural World, Colman's, article from, on Apple-tree Bark-louse, V, 77
Rural World, article from, on Fall Army Worm, III, 109
 article from, on Grape Phylloxera, IV, 55, VI, 84
ruscarius, *Elaphrus*, VIII, 52
 Rust-red Social Wasp, V, 54
 Rutbottom, W. F., on Rocky Mountain Locust, IX, 117
rusticella, *Setophaga*, VI, 27
- S.
- Sacramento Union*, article from, on Silk Industry, IV, 80
salticis-strobiloides, Gall, VI, 155
saligneana, *Euryptychia*, II, 134, Supp., 57
saltator, *Orocharis*, I, 138, V, 119, Supp., 60, 62
Saltatoria, a section of Orthoptera, V, 14
Samia cecropia, IV, 103, Supp., 55
columbia, IV, 107, 111, 128, Supp., 55
cynthia, IV, 112
guerinii, IV, 112
ricini, IV, 112
samia, *Oryctus*, IV, 110, 111, Supp., 52
 Sanborn, F. G., on frame for insect net, V, 31
sanguinea, *Cycloneda*, Supp., 53
Saperda bivittata, I, 42, II, 19, III, 6, VII, 27, Supp., 53
candida, Supp., 53
discoidea, V, 106
populnea, IV, 22
Sarcophaga, II, 110
carnaria, VII, 180, IX, 95, Supp., 60
 var. *mantivora*, VII, 180
sarracenia, VII, 180, 181, IX, 95, Supp., 60

- Sarracenia* Flesh-fly, VII, 181
sarracenia, *Sarcophaga*, VII, 180, 181, IX, 95, Supp., 60
 Satellite Sphinx, II, 76
satellitica, *Philampelus*, II, 76
Saturnia maia, IV, 41, V, 127
 io, V, 133
saucia, *Agrotia*, I, 74, Supp., 55
 Saunders, Wm., Experiments with poisons for Potato-beetle, IV, 14
 on Grape-seed Maggot, II, 93
 on Imported Currant worm, IX, 12, 14
 on Pea-weevil, III, 49
 Saunders, W., on *Oidium Tuckeri* in America, V, 69, 70
 Saw-flies, II, 8, V, 9, 10, VIII, 38
 Sawyer's Canker Worm trap, VI, 26
scabiei, *Acarus*, VI, 61
scabrosellus, *Nemotois*, V, 160
scabrum, *Trombidium*, VII, 175
 Scale of Bark-louse, True Nature of, V, 80
scandens, *Agrotia*, I, 76, 78, III, 6, Supp., 55
 Scarlet Mite, VII, 175
 Tanager destroying Canker Worm, VI, 27
Scenopinus, V, 8
Schizoneura, Supp., 87
lanigera, Supp., 59
Schenherri, *Pachyrhynchus*, III, 57
Sciara, VIII, 23, 24, Supp., 59
Scientific American, article from, on Colorado Potato-beetle, IX, 35
Scolia, VII, 174
bicincta, VI, 124
flavifrons, VI, 124
Scolytida, III, 6
scolytivorus, *Bracon*, V, 106, Supp., 67
Scolytus, III, 6, V, 106
caryce, V, 103, Supp., 54
destructor, V, 104
muticus, V, 105, 107
4-spinosus, V, 105, 107, Supp., 54
scribonia, *Epantheria*, IV, 141, 143
scrutator, *Calosoma*, II, 103, III, 129, VIII, 52
scudderiana, *Hedya*, Supp., 57
 Scudder, S. H., on Protective resemblance in Butterflies, III, 166
 on Rocky Mountain Locust, VIII, 109
 on Southern Cabbage Butterfly, II, 104
sculptilis *Sphenophorus*, Supp., 54
scutellaris, *Anthonomus*, Supp., 54
Scutellera, a family of Heteroptera, II, 32, 33, IV, 19, VII, 48
Scymnus, II, 25, 27, VI, 51, VII, 39
cervicalis, I, 122, V, 100
consobrinus, V, 100
terminatus, V, 100
 Seabrook, W. B., on Cotton Moth, II, 40
Sedalia Press, article from, on White Grub, I, 154
 Seed corn maggot, I, 154
 Curculio of the Grape, I, 129
Seiurus aurocapillus, VI, 27
Selandria, V, 26
cerasi, II, 18, VII, 27

- Selandria rosea*, II, 19, VII, 27, IX, 19
rubi, I, 52
selene, *Attacus*, IV, 125
Semaria prunivora, I, 63, III, 6, 25, V, 51
Semioteilus clisicampae, III, 120
semisculpta, *Ohrysobothris*, VII, 71
senatoria, *Dryocampa*, III, 123, IV, 41
Senomtopia bicincta, V, 140
militaris, II, 50
septemdecim, *Cicada*, I, 18, 19, 20, II, 19, III, 6, V, II
 27, Supp., 68, 59
septentrionis, *Brenthius*, VI, 116, 117
Sericaria mori, IV, 75
sericeum, *Trombidium*, VII, 175, Supp., 63
sericeus, *Asilus*, II, 123
Spermophagus robiniae, III, 45
serratus, *Bruchus*, III, 56, Supp., 70
sesostris, *Ampelogypter*, Supp., 71
Baridius, III, 60, Supp., 71
Setophaga ruticilla, VI, 27
 Seventeen-year Locust, II, 19, III, 6, VII, 27
 Seventeen and thirteen year broods of the Period-
 ical Cicada, I, 18
 Sex, law of, V, 85
 Sex not affected by food, VIII, 19
 Sexed Phylloxera, VIII, 158
 Shad-fly, V, 143
 Shane, J. B., on Rocky Mountain Locust, IX, 118
 Shattuck, J. C., on Rocky Mountain Locust, VII,
 178
 Shaw, G. W., on Soldier Bugs, V, 51
 Sheep Bot-fly, I, 161
-ticks, V, 13
 Shepherd, S., on Hickory Bark-borer, V, 105
 Shimer, Dr. H., on Chinch Bug, II, 20, 24, 26, 30,
 VII, 39, 40
 Short-winged Ichneumon, IX, 55
 Shulz, G. E., on Rocky Mountain Locust, IX, 70
sibylla, *Limenitis*, III, 171
Sigalphus Curculio Parasite, III, 25
Sigalphus curculionis, III, 25, 27, Supp., 67
var. rufus, III, 27, Supp., 63
signatipes, *Ichneumon*, III, 69
signifer, *Cassida*, II, 63
 Silk-growing in California, IV, 73
 Kansas, IV, 82
 Missouri, IV, 83
 Silkworm, The *Allanthus*, IV, 112
 American, IV, 104
Cecropia, IV, 103
 Luna, IV, 123
 Mulberry, IV, 75
 Perny, IV, 137
 Polyphemus, IV, 125
 Promethea, IV, 121
 Tusseh, IV, 138
 Yama-mal, IV, 130
 Silkworms, IV, 72
 Silky *Asilus*, II, 123
 Silky Mite, VII, 175, IX, 91
Silpha americana, VI, 100
 Simmons & Tillson, on Grape root Borer, I, 125
 Simpson, T. W., on Rocky Mountain Locust, IX, 75
Sinea diadema, Supp., 58
Sinoxylon basillare, IV, 53, 54, V, 54
Sinoxylon, the Red-shouldered, IV, 52, 53, 54, V, 54
siro, *Tyroglyphus*, VI, 52
Sitophilus granarius, II, 10, III, 60
 Skimmed Milk as remedy for Gooseberry Span-
 worm, IX, 6
 Skunk destroying Locust eggs, IX, 91
 Slug Worm of the Pear, II, 19
 Rose, II, 19, VII, 27
 Slug-worms, V, 26
 Small White Bristly Cut-worm, I, 86
 Smeared Dagger, III, 70
 Smiley, W., on Rocky Mountain Locust, IX, 70
 Smith, H. J., on Green-striped Maple-worm, V, 137
 Smith, Jos., on Snake Worm, VIII, 24
 Smith, J. F., on Rocky Mountain Locust, IX, 68
 Smith, J. H., on Rocky Mountain Locust, VIII, 62
 Smith, S. I., on oviposition of *Conocephalus*, VI,
 155
 Smith, S. S., on Army Worm, VIII, 39
 Smith, T., on seedling of Yuccas, V, 159
 Smith, W. A., on Rocky Mountain Locust, IX, 70
 Smith, W. R., on Rocky Mountain Locust, VIII, 85
smithii, *Cryptus*, IV, 111
 Snake-worms, VIII, 23, 24
 Snapping-beetles, III, 6
 Snidow, W. L., on Rocky Mountain Locust, IX, 71
 Snout-beetle, II, 92, III, 5, 10, 37, VI, 116
 The Imbricated, III, 57
 Snow, F. H., on False Chinch Bug, V, 111
 on Rocky Mountain Locust, VIII, 77,
 114, IX, 93
 Snowy Tree-cricket, V, 120
 Snyder, C., on Rocky Mountain Locust, VII, 194
socialis, *Spizella*, VI, 27
 Soda as remedy for Apple-tree Bark-lice, I, 17
 Soldier-bug, The Glassy-winged, III, 137
 The Spined, I, 77, 89, 113, II, 32, 34, IV,
 19, V, 51, 133, IX, 17
 Soldier-bugs as enemies of Cicada, I, 26
 Codling Moth, V, 51
solidaginis, *Trypeta*, I, 13, 173
 Solidago Gall-maker, II, 134
 Gall-moth, I, 173, II, 20, 132
 Song-sparrow destroying Canker Worm, VI, 27
soror, *Ohrysobothris*, VII, 71
 Soreby, B. A., on attracting Boll-worm Moth by
 sweets, III, 108
 Sounds from insects sometimes inaudible, VI, 153
 Southern Cabbage Butterfly, II, 104
 Cotton Army-worm, II, 49, VIII, 34
 Grass-worm, II, 41
 Southern Farmer, article from, on Paris Green for
 Cotton Worm, VI, 19
 Span-worms, II, 110
 Spanish blister-beetle, V, 18
Spathius trifasciatus, V, 106, Supp., 67
 Species, definition of, VI, 143, VII, 115, 179
 geographical range of, IX, 82
speciosus, *Stizus*, I, 27, Supp., 52
 Speckled cut-worm, I, 84
Spectrum femoratum, VI, 150, VII, 181
Spermophagus robiniae, III, 45
Sphecius, Supp., 52
Sphenophorus pulchellus, III, 60
pustulosus, Supp., 54
sculptilis, Supp., 54
13-punctatus, III, 60, Supp., 54

- Sphenophorus truncatus*, III, 59
zeæ, III, 59, Supp., 54
- Sphinges, V, 12
- Sphingidæ*, III, 123, IV, 86
- Sphinxæ*, II, 71, 74, 76
carolina, I, 96, IV, 129
crantor, II, 74
lycaon, II, 76
myron, II, 71
5-maculata, I, 85, V, 125
- Sphinx moth, II, 78, V, 56, VI, 162
- Spiderwort Owllet moth, III, 113
- Spilonota roborana*, Supp., 57
- Spilosoma virginica*, III, 68
- Spined Soldier-bug, I, 77, 89, 118, II, 32, 34, IV, 19, V, 51, 133, IX, 17
- spinosa*, Arma, I, 77, 89, 118, II, 32, IV, 19, Supp., 58
Phylloxera, VII, 118
- spiralis*, *Trichina*, IV, 70
- Spizella socialis*, VI, 27
- Spotted Ladybird, I, 112, II, 25, 27, 36, V, 149, VII, 39
Pellidnota, III, 77
- Spray Machine, Peck's, VIII, 4
- spretis*, *Acridium*, VII, 128
- spretum*, *Acridium*, VII, 128
- spretus*, *Caloptenus*, VII, 121, 128, VIII, 57, 109, 114, Supp., 89, 90
- Spring in Europe and America, VI, 151
- Spring Canker-worm, VII, 80, VIII, 17, 18
Canker Worm Moth, VIII, 37
- Sprinkler for the use of Paris Green Water, VI, 20, VII, 15, VIII, 5
- Squash bug, I, 118, II, 81, VII, 46
Borer, II, 64
- St. Joseph Herald*, article from, on Colorado Potato-beetle, III, 97
article from, on Rocky Mountain Locust, VIII, 67, 69, 73, 75
- St. Louis *Globe-Democrat*, articles from, on Rocky Mountain Locust, VIII, 68, 71, 92, 155
Republican, articles from, on Rocky Mountain Locust, VIII, 69, 73, 75, 148, IX, 73
- Stag-beetle, V, 145
- Stainton, H. T., on *Pronuba yuccasella*, V, 160
- Stalk-borer, III, 105, VIII, 37
of the Potato, I, 92
weevil of the Potato, I, 93
- Staphylinidæ*, VI, 162, VIII, 20, 24
- State University, cabinet for, VII, (preface, p. 5)
- Steel-blue Flea-beetle, I, 101, III, 79
- Stelle, J. P., on Periodical Cicada, IV, 32
- Stenocorus villosus*, I, 25
- Stenopogon consanguineus*, IX, 98
- Stenoptycha*, Supp., 57
- Stevenson, Hugh, on Rocky Mountain Locust, IX, 70
- stigma*, *Dryocampa*, III, 123, IV, 41, V, 141
- Sting of the Periodical Cicada, I, 26
- Stinging larvæ, V, 125
- Stiretrus ambriatus*, I, 114, II, 34, IV, 20
- stirpicola*, Crabro, IX, 95, Supp., 89
- Stizus grandis*, I, 27, Supp., 52
speciosus, I, 27, Supp., 52
- Stomoxys*, V, 13
- Stone, W. B., on False Chinch Bug, V, 111
- Strachia histrionica*, IV, 35
ornata, IV, 38
- Strawberry Crown-borer, III, 42
Leaf-roller, I, 142
Worm, IX, 27
Descriptive, IX, 28
Remedies, IX, 28
- Strepsiptera*, V, 15
- striata*, *Dendroica*, VI, 27
- Stridulation of Acrididæ, VI, 153
Burying beetles, III, 14
Gryllidæ, VI, 134
Horned Passalus, IV, 139
Katydids, III, 154
Locusts, III, 153
Ecanthus latipennis, Supp., 60
Orocharis saltator, Supp., 62
Plum Curculio, III, 14
Three-lined Leaf-beetle, III, 14
- Stringer, J. E., on Rocky Mountain Locust, IX, 71
- striolata*, *Haltica*, III, 44
Phyllotreta, III, 83
- Striped Blister-beetle, I, 96, 115
Bug, II, 64, 66
- Striped Chrysopa, II, 129
Cucumber-beetle, II, 64, 65, III, 6
Flea-beetle, III, 44
Squirrel destroying Locust eggs, IX, 91
- strobi*, *Pisodes*, III, 60
- Strobiloides* Gall on Willow, VI, 155
- Strong, W. C., on grafting grape-vine, VII, 114
- Strongylium tenuicolle*, VI, 118
- Stroop, L. J., on Archippus Butterfly, III, 151
- Structure, adaptation of, to habit, VI, 154
- Struggle for existence, VIII, 122
- Stylopidæ*, V, 15
- Stylops*, V, 15, VI, 125
- suavella*, *Myelois*, IV, 41, Supp., 79
- Subangular Ground-beetle, I, 58
- subangulata*, *Aepidoglossa*, I, 58
- subcadens*, *Celena*, Supp., 56
- subcostalis*, *Xylina*, III, 136, Supp., 75
- subcyaneus*, *Ichneumon*, III, 69
- subgothica*, *Agrotis*, I, 81, 83, III, 151, Supp., 55, 56
- Subimago, Chrysopa issues from cocoon as, I, 57, II, 26
- Subjoined *Hadena*, I, 84
- subjuncta*, *Hadena*, I, 84
- Submersion as remedy for Chinch Bug, VII, 81
Phylloxera, IV, 69, VI, 55
Rocky Mountain Locust, VII, 182
- suffusa*, *Agrotis*, Supp., 55
- suilla*, *Colaspis*, III, 82
- Suits due to insects, VI, 96
- sulcatus*, *Otiorynchus*, III, 11
- Sulphide of Potassium as remedy for Gooseberry Span-worm, IX, 7
- Sulphur as remedy for Phylloxera, IV, 69
- Sulphuretted hydrogen as remedy for Phylloxera, IV, 69
- Sumach-beetle, The Jumping, VI, 118
- Summer Yellow Bird destroying Canker Worm, VI, 28
- surinamensis*, *Sylcanus*, III, 6

- suturalis*, *Anthonomus*, III, 60
 Swarming of butterflies, III, 151
 Sweetened water for Codling Moth, IV, 27
Sylvanus surinamensis, III, 6
sylvatica, *Oligocampa*, II, 7, 37, III, 121, IV, 41, Supp., 55
symphoricarpi, *Tortrix*, I, 154, Supp., 82
Synchlora, Supp., 79
 albolineata, Supp., 79
 rubivorana, Supp., 79
Synemon theresa, VIII, 178
 Synopsis of the American species of the genus
 Phylloxera, VII, 117
Syrphidae, V, 13
Syrphus-fly, VI, 51
 of Root-louse, I, 121
 Larva, V, 149, VI, 51
Systæchus, Supp., 60
- T.**
- Tabanidae*, VI, 123
Tabanus atratus, II, 128, 129, 130
 bovinus, II, 129
 cinctus, II, 128
 costalis, II, 128
 lineola, II, 128
tabescens, *Erax*, II, 124
tabida, *Chrysopa*, VII, 106
Tachina, II, 103, VIII, 107
 anonyma, IV, 129, V, 133, 139, VII, 178, VIII, 179, IX, 54
 archippivora, III, 116, 150, V, 149
 auricincta, V, 140
 bicincta, V, 140
 bifasciata, V, 140
 phycitæ, IV, 40, Supp., 88
Tachina-fly, II, 109, 110, 120, III, 62, 129, 142, 149, 157, 161, IV, 123, V, 133
 The Anonymous, VII, 178
 of Army-worm, IV, 109, VIII, 50
 of Cecropia Worm, IV, 108
 The Red-tailed, VI, 96, VII, 179
Tachinidae, V, 13
 Talbot, R. H., on Rocky Mountain Locust, IX, 68
tapetzella, *Tinea*, II, 10
Tarantula, II, 106
tarda, *Tiphia*, VI, 126
 Tarnished Plant Bug, II, 113, 114, IV, 20
 Tawny Emperor, VI, 140
 Earlier stages, VI, 141, 148
 Food-plants, VI, 141
 Parasite, VI, 142
 Taylor, A. S., Locust History in America, VII, 133
Teles polyphemus, IV, 125
Telephorus bilineatus, IV, 29, 30
telifera, *Agrotis*, I, 80, Supp., 55
 Ten-lined Spearman, I, 103
Tenebrio molitor, II, 9, 10, VI, 118, IX, 43
 obscurus, II, 9, 11, IX, 43
 Tenebrionid Larva, VI, 118
 Tent Caterpillar, II, 100, III, 130, 132
 Tent Caterpillar of the Apple, II, 7, III, 117
 Development, III, 119
 Eggs, III, 118
 Food-plants, III, 120
 Remedies, III, 120
 Tent Caterpillar of the Forest, II, 7, 37, III, 120, 121, 134, V, 128, VIII, 23
 Is it ever destructive? III, 127
 Larval habits of, III, 124
 Natural history of, III, 121
 Remedies for, III, 128
 Summary, III, 129
Tenthredinidae, V, 10, VI, 70
tenuicollis, *Strongylium*, VI, 118
Teras oxycoecana, Supp., 83
Terebrantia, a section of Hymenoptera, V, 9
Termes flavipes, IX, 43
 frontalis, II, 11
tesselata, *Halassidota*, III, 127
Tetracha virginica, I, 115
Tettigonia, I, 171, III, 38
Tettix granulata, VIII, 150
tezana, *Cassida*, Supp., 54
 Texas, Locust History in, VIII, 88, IX, 76
 Text Books on Entomology, V, 44
textor, *Hyphantria*, III, 130, 132, Supp., 55
Thecla, VI, 140, VIII, 177
thelxiope, *Heliconia*, III, 173
Theognis albicinctus, V, 154
 phyllopus, V, 154
theresa, *Synemon*, VIII, 178
Thersilochus, III, 28, Supp., 65
 Thick-legged Buprestian, VII, 72
thuiella, *Bucculatrix*, IV, 51
 Thirteen-spotted Lady-bird, I, 112
 Thirteen-year Locust, II, 19, VII, 27
 Thistle Plume, I, 180, II, 112
 Thomas, Prof. Cyrus, Controversy on habits of
 Army Worm, II, 47
 Description of Red-logged
 Locust, VII, 126
 on Army Worm, VIII, 43, 45
 on Colorado Potato-beetle, VIII, 8
 on Rocky Mountain Locust, VII, 141, VIII, 115, 153
 Thompson, E. A., on remedy for Peach Borer, I, 49
 Thompson, Wm., on Rocky Mountain Locust, IX, 118
 Thornburg, J. M., on Rocky Mountain Locust, IX, 72
 Thornton, Dr. C. W., on Army Worm, III, 111
 Thrasher, J., on Rocky Mountain Locust, IX, 74
 Three-banded Spathius, V, 106
 Three-lined Leaf-beetle, I, 99, II, 58, III, 14
Threnodes, VIII, 170
Thripidae, V, 16
Thrips, II, 6, III, 29, V, 16, 118, VI, 50
 phylloxera, VI, 50
Thymele, VIII, 175
thymi, *Nysius*, V, 113, Supp., 85
Thyreus abbotii, II, 78
thyridopterigis, *Hemiteles*, I, 150, Supp., 65
Thyridopteryx ephemeræ formis, I, 147
Thysanoptera, V, 16
tibiale, *Trochilium*, VI, 113, Supp., 72
 Tiger-beetles preying on Locusts, IV, 98
 Tiger-moth, IV, 88
 The Isabella, IV, 143

- Tilden, Josiah, on Rocky Mountain Locust, IX, 72
 Tile-horned Prionna, II, 89, 90
 Dimorphous male form, II, 90
 Food-plants, II, 89, 90
 Remedy, II, 91
 Titta, R. H., on parasite of Flat-headed Borer, VII, 74
tinctorium, *Trombidium*, VII, 175
 Tinea, the Cabbage, IV, 36
Tinea pellionella, II, 10
 pustulella, Supp., 58
 tapetzella, II, 10
 vestianella, II, 10
Tineida, II, 133
 On a new Genus in, V, 150
Tingis pyri, II, 33
Tiphia femorata, VI, 124
 inornata, VI, 123, 126
 tarda, VI, 126
 transversa, VI, 126
Tipula, I, 180
Tipulidæ, II, 132
tipuliformis, *Ægeria*, II, 10
 Titmouse, Blackcapped, destroying Codling Moth, IV, 28
tityrus, *Epargyrtus*, VIII, 173
Tityrus Skipper, II, 125
 Tobacco Worm, counterworking the, V, 56
Tolmerus, IX, 98
 Tomato-gall, Grape-vine, V, 117
 Tomato-worm, I, 95, IV, 17
 Tortoise-beetle, the Black-legged, II, 63
 Golden, II, 62
 Mottled, II, 63
 Pale-thighed, II, 62
 Tortoise-beetles, I, 100, II, 56, 58, 59, 61
Tortrix botrana, Supp., 57
 cinderella, IV, 47, Supp., 82
 malivorana, IV, 47, Supp., 82
 oxyceocana, Supp., 82
 paludana, VI, 103
 rileyana, I, 153, 154, Supp., 81
 symphoricarpi, I, 154, Supp., 82
 vaccinivorana, Supp., 82
 Townley, John, on Climbing Cut-worms, I, 71
trabeata, *Ossida*, II, 63
 Trabue, A. E., on Army Worm, II, 44, VIII, 27
Tragocephala viridifasciata, VIII, 149
 Transformation of insects, remarks on, III, 146
transversa, *Tiphia*, VI, 126
transversus, *Bruchus*, Supp., 70
 Traps for Canker Worm, VI, 25, 26, VIII, 20, 21
 Codling Moth, I, 66, IV, 23, V, 46
 Plum Curculio, III, 15
 Treadwell, C. C., on parasite of Rocky Mountain Locust, IX, 93
 on Rocky Mountain Locust, IX, 68
tredecim, *Cicada*, I, 19, II, 19, III, 6, VII, 27, Supp., 58, 59
tredecimpunctata, *Hippodamia*, I, 112
tredecimpunctatus, *Sphenophorus*, III, 60, Supp., 54
 Tree-cricket, I, 138
 The Jumping, V, 119
 The Snowy, V, 120
- Tree-hopper, the Buffalo, V, 121
 Tree-hoppers, III, 6
 Trivoltin Silk-worms, IV, 85
trichas, *Geothlypis*, VI, 126
Trichina spiralis, IV, 70
Trichobaris, Supp., 54
Trichodactylus, VII, 106
Trichogramma (?) *minuta*, III, 158, Supp., 68
Trichogrammida, VI, 142
Trichoptera, V, 16
tricos, *Agrotis*, Supp., 55
tridens, *Acronycta*, II, 121, Supp., 73
trifasciatus, *Spathius*, V, 106, Supp., 67
trilineata, *Lema*, I, 99, II, 58, III, 14, IV, 8
 Trim Ladybird, II, 25, 27, VII, 39
 Trimble, Dr., on Quince Curculio, III, 36
 Trimeria, a division of Heteroptera, V, 13
trinotatus, *Baridius*, I, 93, III, 60, Supp., 54
Triphleba, Supp., 58
tristis, *Coreus*, I, 113, II, 31, VII, 46, Supp., 58
tritici, *Diplosis*, II, 10
Trochilium, VI, 27
 acerni, VI, 108
 marginatum, VI, 113, Supp., 72
 tibiale, VI, 113, Supp., 72
Trogosita nana, III, 6, V, 51
troilus, *Papilio*, III, 169
Trombidium holosericeum, VII, 175
 seabrum, VII, 175
 sericeum, VII, 175, IX, 91, Supp., 63
 tinctorium, VII, 175
 True, Dr. U. T., on Locusta, VII, 168
 Trough remedy for Canker Worm, VI, 26
 Truland, N. B., on Rocky Mountain Locust, VII, 159
 Trumpet-gall, Grape-leaf, V, 118
truncatus, *Sphenophorus*, III, 59
Trupanea apivora, I, 168, II, 122, Supp., 60
 vertebrata, II, 123, Supp., 87
Trypeta pomonella, I, 108, III, 6, 91
 solidaginis, I, 13, 173
Trypoxylon, VI, 162
tuckeri, *Oidium*, VI, 30, 63, 79, 85
turbatella, *Dakruma*, Supp., 57
turca, *Leucania*, VIII, 43
Turdus fuscescens, VI, 27
 migratorius, VI, 27
 Turnip Flea-beetle, III, 63
turnus, *Papilio*, VI, 145
 Tussock Silk-worm, IV, 138
 Tussock Moths, II, 15
 Tuttle, W. F., on Rocky Mountain Locust, IX, 69
 Twelve-spotted Diabrotica, II, 66
 Twice-stabbed Lady-bird, I, 16, V, 100
 Twig-borer, III, 6
 Twig-girdler, III, 6
 Two-lined Soldier-beetle, IV, 29
 Two of our common Butterflies, III, 142
 Two-striped Locust, VII, 124, 173, VIII, 150
 Potato-beetle, II, 61
 Saperda, I, 43, III, 6
Tyloderma fragariae, Supp., 72
Tyroglyphus echinopus, VII, 106
 entomophagus, VI, 52
 phylloxera, VI, 52, 53, 81
 siro, VI, 52

C.

- ulmi*, *Eriosoma*, I, 123, Supp., 87
 Unadorned Tipthia, VI, 123
 Unarmed Rustic, I, 72, III, 114
undecimlineata, *Doryphora*, VIII, 10
 Uni-banded Ichneumon-fly, III, 77
unicolor, *Corinelaena*, II, 85
Macrobasia, Supp., 54
unifasciatus, *Ichneumon*, III, 71
unio, *Eudryas*, I, 186, II, 83, III, 63, VI, 90, 92, 95
unipuncta, *Leucania*, I, 109, II, 5, 11, 37, 55, VIII, 22,
 24, 29, Supp., 76
Noctua, II, 41
unipunctata, *Physonota*, Supp., 53
Urania, VIII, 170
Uroceridae, V, 10
Uroplata rosea, III, 6
Uropoda americana, IX, 41
vegetans, IX, 40
Ursula butterfly, III, 163
ursula, *Limenitis*, III, 163, 167, 168, 169, 171
urtica, *Vanessa*, III, 167
 Urticating larvæ, V, 126
 Useful Labens, VII, 75
Utica (N. Y.) *Herald*, article from, on Paris Green,
 VII, 9

V.

- vadosus*, *Epicærus*, III, 58
vagabundus, *Pemphigus*, I, 112, 120, VII, 97
 Valley Farmer, article from, on injury done by
Cicadas, I, 29
 Van Deman, H. E., on Rocky Mountain Locust,
 IX, 65
 on Rose Chafer, V, 108
Vanessa antiopa, V, 148
atalanta, V, 148
urtica, III, 167
 Vaporers Moths, II, 15
 Variation in locusts, VIII, 155
 number of antennal joints, II, 89
 wing-venation, IX, 22
varius, *Anthrribus*, III, 10
varicornis, *Bruchus*, III, 55, 56, Supp., 60, 70, 71
Ecanthus, Supp., 61
 Variegated Cut-worm, I, 72, II, 50
variolarius, *Euschistus*, Supp., 58
vastator, *Oscinis*, I, 161
rastatrix, *Phylloxera*, III, 85, IV, 55, VI, 30, 63, 66,
 86, 87, VII, 91, 117, VIII, 157
Rhizophis, VI, 31
Velleius dilatatus, IV, 22
ventricosus, *Nematus*, VI, 43, 149, IX, 10
Ver du Coeur, II, 107
 Vermea, a section of Segmented Animals, V, 6
vernata, *Anisopteryx*, I, 109, II, 94, VI, 28, VII, 80, 86
Palaeocrita, VIII, 13
Phakena, VII, 80
versicolor, *Quiscalus*, VIII, 124
 Vertebrata, a subkingdom of the Animal Kingdom, V, 6
vertebrata, *Trupanea*, II, 123, Supp., 87
Vespa crabro, IV, 22
maculata, Supp., 48
vulgaris, VI, 125
vestalis, *Callimorpha*, III, 133

- vestianella*, *Tinea*, II, 10
villosus, *Elaphidion*, III, 6
 Vinegar for Codling Moth, IV, 27
 Vine Root-borer, I, 124
violaceus, *Corynetes*, VI, 101
Vireo olivaceus, VI, 27, VIII, 124
Vireo, Red-eyed, VIII, 120
virens, *Contopus*, VI, 27
virginiana, *Ortyx*, II, 28, VII, 41
 Virginia Tiger-beetle, I, 115
virginica, *Spilosoma*, III, 68
Tetracha, I, 115
viridascens, *Glyphe*, II, 53, VIII, 68
viridifasciata, *Tragocephala*, VIII, 149
viridia, *Callochloa*, III, 150
Caloptenus, VIII, 117
viticida, *Fidia*, I, 182, Supp., 58
viticola, *Botrytis*, VI, 36
vitifolia, *Daktylophæra*, I, 13
Pemphigus, I, 13, III, 83, 86, VI, 31
Phylloxera, II, 27, III, 84, IV, 55
vitis, *Aphis*, I, 13
Fidia, Supp., 53
Isosoma, II, 92, 93
Lasioptera, V, 117
Madarus, I, 131, Supp., 71
Proctria, II, 86
vitis-coryloides (Gall), V, 116
pomum (Gall), V, 114
tomatos (Gall), V, 117
viticola (Gall), V, 118
vitisana, *Peritymbia*, IV, 55, VI, 31
viticella, *Carpocapsa*, I, 133
vitivorana, *Penthina*, I, 133, Supp., 57
vitreus, *Mesochorus*, II, 52, VIII, 53
vitripennis, *Caprus*, III, 139
Campyloneura, III, 137
vittata, *Diabrotica*, I, 100, II, 62, 64, III, 6
Lytta, I, 96
vittatus, *Chrysops*, II, 129
 Viviparous nature of *Æstrus ovis*, I, 104
 Vorhees, H., on the use of Paris Green, VI, 14
vulgaris, *Vespa*, VI, 125
vulnerator, *Pachymerus*, IV, 28

W.

- Walking-leaves, III, 159
 Walking-stick, III, 159, V, 14, VI, 156, VII, 161
 Wallace, A. R., on Evolution, III, 172
 Wallace, T. D., on Rocky Mountain Locust, IX, 74
 Walnut Case-bearer, IV, 42, V, 49
 Case of, IV, 42
 Natural enemies of, IV, 43
 Walnut Tortrix, I, 153
 Walsh, B. D., controversy on habits of Army
 Worm, II, 47
 description and habits of larvæ of
 Black Breese-fly, II
 130, 131
 of Corn Sphephenorus,
 III, 59
 of Native Currant
 Worm, IX, 28
 of Pickle Worm, II, 67
 of Red-tailed Tachina
 fly, II, 51

- Walsh, B. D., experiments with *Curculio*-larvæ, I, 55
 on Colorado Potato-beetle, I, 102
 on Hellgrammite larvæ, V, 144
 on Native Currant Worm, IX, 25
 on Oviposition of Katydidæ, VI, 154
 on Rocky Mountain Locust, VII, 182
 on Thirteen-year Cicada, Supp., 68
- Walshia amorphella*, II, 182, 123
- Ward's *Curculio*-catcher, III, 20
- Warblers destroying Canker Worm, VI, 27
- Warder, R. H., on mould infesting Cicadas, I, 26
- Warrensburg (Mo.) *News*, article from, on Rocky Mountain Locust, VIII, 108
- Water Bugs, a division of Heteroptera, V, 12
- Water-moth, V, 16
- Wax-worm, I, 106
- Weeping Lacewing, II, 26, VI, 51, VII, 40
- Weidemeyerii*, *Limenitis*, III, 171
- Western Farmer*, article from, on Birds destroying Canker Worm, VI, 37
- Western Rural*, articles from, on Colorado Potato-beetle, IV, & VIII, 8
 article from, on Peach Borer, I, 46
 article from, on Rocky Mountain Locust, VII, 135
- Western Striped Cut-worm, I, 81
- Wetherell, W. H., on Rocky Mountain Locust, IX, 74
- Wheat Cut-worm, I, 87, III, 112
- Wheat-Head Army-worm, IX, 50
 Descriptive, IX, 55
 Habits and natural history, IX, 52
 Natural enemies, IX, 54
 Remedies, IX, 55
- Wheat Midge, II, 10, 13, 16, 70, V, 13, IX, 17
- Wheeler, Wm., on Rocky Mountain Locust, VII, 151
- White, E. M., on counterworking the Tobacco Worm, V, 56
- White, J. D., on Rocky Mountain Locust, IX, 72
- White, J. K., on Rocky Mountain Locust, VIII, 62, IX, 68
- White, J. W. C., on Rocky Mountain Locust, VII, 152
- White Ant, II, 11, V, 15, IX, 43
 Bark-louse, V, 74
 Grub, I, 88, 156, II, 16, 19, III, 31, 78, IV, 17, 35, VII, 27
 fungus, I, 158, VI, 123, 125
 parasite, VI, 123
- Currant Worms, IX, 14
- Hellebore as remedy for Currant Worms, IX, 14
- lined Morning Sphinx, III, 140, 141, VIII, 128
 Green Larva of, VIII, 122
 Black Larva of, VIII, 122
- marked Tussock-moth, I, 144, VI, 29
- Pine weevil, III, 60
 Worm, Abbot's, IX, 29
 Le Conte's, IX, 32
- winged Crossbill destroying Canker Worm, VI, 27
- Whitely, Joe., on Rocky Mountain Locust, IX, 71
- Whitescarver, C. S., on Rocky Mountain Locust, IX, 70
- Whitman, A., on Enemies of Rocky Mountain Locust, IX, 96
- Whittemore, O. A., on Rocky Mountain Locust, VII, 154
- W-marked Cut-worm, I, 79
- Wielandy, J. F., non-publication of report, VII (preface, p. 5)
- Wier, D. B., on remedy for Round-headed Apple-tree Borer, I, 46
- Wier, Mrs. H., on trapping *Curculio*, III, 16
- Wier's Apple-worm Trap, IV, 33, V, 46, VI, 10
- Wilcoxi*, *Calosoma*, VIII, 62
- Williams, Prof. A. D., on Rocky Mountain Locust, IX, 65
- Willow-apple Saw-fly, IX, 20
- Wilson, R. P. C., on Rocky Mountain Locust, IX, 75
- Wilson, T. W., on Rocky Mountain Locust, IX, 75
- Wilson's Thrush destroying Canker Worm, VI, 27
- Wings, development of, VI, 40
- Winnipeg Standard*, article from, on Rocky Mountain Locust, IX, 78
- Winter-egg of *Phylloxera*, VI, 42
- Wire Worm, II, 16
- Wise, Jno. C., on Rocky Mountain Locust, VIII, 82, IX, 93
- Witherton, McNeil, on remedy for Canker Worm, II, 101
- Wombat, II, 12
- Wood Nymph, The Beautiful, II, 83, 84, III, 64, VI, 83, 91, 95
 The Pearl, II, 80, 83, 84, III, 63, VI, 90
- Woodpecker, Red-headed, destroying locust, VIII, 124
- Wood Pewee destroying Canker Worm, VI, 27
- Wooly Aphis, III, 95, IV, 100, IX, 43
 Apple-tree louse, I, 118
 -bear, IV, 88
 Elm-tree louse, I, 123
 Plant-louse, I, 119
- Workman, R. A., on Rocky Mountain Locust, VIII, 68, IX, 70
- Wratten, G. L., on Grape *Phylloxera* in California, VI, 82
- Wyoming, Locust History in, VIII, 88, IX, 59
- X.
- Xabea bipunctata*, Supp., 61
- Xerophylla*, III, 94
caryæ-semen, VII, 117
- Xiphidium*, VI, 155
- Xyela*, IX, 20
- Xyleutes*, VIII, 175
- Xylina*, III, 135
bethunei, III, 136, Supp., 75
capax, III, 136, Supp., 75
cinerea, III, 134, V, 125, Supp., 74
cinerosa, III, 136, Supp., 75
conformis, III, 136, Supp., 75
subcostalis, III, 136, Supp., 75
xylina, *Anomis*, II, 37, 40, VI, 17, VIII, 23, Supp., 56
Ophiura, II, 40

Y.

- yama-mai*, *Antheraea*, IV, 180
Attacus, IV, 74, 180, 188
Yama-mai Silkworm, IV, 180
 Acclimatization in Europe and America, IV, 130
 Culture in Japan, IV, 134
 Larval changes, IV, 132
 Parasite, IV, 136
 Value of the cocoon, IV, 133
 Yellow Bear, III, 141
 Yellow-billed Cockoo destroying Canker Worm, VI, 28
 Locusts, VIII, 124
 -headed Cutworm, I, 87
 -jacket, VI, 125
 -tail Moth, V, 126
 -tailed Tachina Fly, II, 51, VIII, 53
 Warbler destroying Canker Worm, VI, 27
 Youmans, Prof. E. L., on Evolution, III, 174
 Young, Waller, on Rocky Mountain Locust, VIII, 64
ypselon, *Agrotis*, Supp., 55
Yucca, insects affecting, V, 154
Yucca Borer, VIII, 169, IX, 129
 Affinities, VIII, 176

Yucca Borer—Continued.

- Biological, VIII, 171
 Bibliographical, VIII, 173
 Descriptive, VIII, 174
 Enemies, VIII, 179
 It is single-brooded, IX, 129
 It thrives in the latitude of St. Louis, IX, 129
Yucca Moth, V, 153, VI, 131, VIII, 37
 Chrysalis, VI, 131
 How the female fertilizes the plant, V, 154
 Larva, V, 155
 Range, V, 159
 Oviposition, VIII, 37
yuccæ, *Castnia*, VIII, 173
 Eudamus, VIII, 173
 Megathymus, V, 129, VIII, 169, 171, 179
yuccasella, *Pronuba*, V, 160, VI, 131, VIII, 171, Supp., 58

Z.

- zea*, *Anthomyia*, I, 154, Supp., 89
 Sphenophorus, III, 59, Supp., 54
 Zebra Caterpillar, II, 112
zetterstedtii, *Platyptilia*, Supp., 84
 Zimb, V, 13
Zophodia convolutella, Supp., 57

INDEX TO PLANTS AND FOOD-PLANTS.

A.

Abies canadensis, I, 24
Acer saccharinum, IV, 108
 Adam's Needle, V, 158
Actinivalis Grape, V, 65, 66, VII, 103
actinivalis, *Vitis*, III, 89, 90, IV, 60, 61, 63, VI, 36, 47, 48
 72, 74, 75, 80, VII, 103
 Agawam Grape, V, 65
Ailanthus, I, 149, 151, III, 130, IV, 75, 82, 112, 118, 120,
 VII, 160
 Tree, A good word for the, IV, 120
Ailanthus glandulosa, IV, 113, 120
alba, *Carya*, V, 105, VII, 117, 118
Morus, IV, 100
album, *Chenopodium*, II, 113, VI, 12
 Alder, II, 121, III, 80
Alnus serrulata, III, 80
aloifolia, *Yucca*, V, 153, VIII, 171, 181, IX, 129
 Alton Large Nutmeg Melon, II, 69
 Alvey Grape, IV, 63, V, 65, VI, 47, VII, 102
amara, *Carya*, V, 104, VII, 118
Amaranthus, VII, 159
blitum, VIII, 61, 119, 121, 122, IX, 122
retrofractus, V, 52, VI, 12
 Amber Grape, VI, 47, 48
Ambrosia, Supp., 54
trifida Supp., 56
americana, *Prunus*, I, 15
 American Grape-vines in Europe, IV, 62, V, 65,
 VII, 116, VIII, 167
 Grape-vines, classification of, IV, 60, VI,
 70
 Ivy, II, 74
americanus, *Oenothera*, II, 35, VII, 48
Amorpha canescens, II, 90
fruticosa, II, 132, V, 136
Ampelopsis, II, 76, VI, 90
quinquefolia, I, 132, II, 74
Anacharis canadensis, II, 11, IX, 43
Andropogon, VI, 155
Angræcum sesquipedale, V, 153
angustifolia, *Yucca*, V, 157, 159, VIII, 169
Apocynum, III, 144, VIII, 119
 Apple, I, 7, 29, 42, 46, 47, 53, 62, 63, 70, 71, 77, 78, 80, 89,
 108, 118, 119, 126, 128, 144, 146, 150, II, 6, 9,
 15, 83, 89, 90, 91, 95, 96, 114, III, 5, 11, 13, 25,
 30, 32, 33, 34, 38, 57, 58, 92, 102, 114, 118, 120,
 124, 125, 126, 127, 132, 135, 141, IV, 22, 25, 29,
 39, 44, 46, 47, 50, 52, 104, 126, 132, V, 51, 74,
 86, 93, 109, 114, 120, 122, 129, VI, 9, 127, 158,
 VII, 47, 72, 73, 146, 159, 169, VIII, 19, Supp.,
 79

Apple, Ben Davis, IV, 45
 Benoni, IV, 52, V, 67
 Dwarf, I, 69, 70
 Early Harvest, V, 86
 Limber Twig, V, 87
 Lowell, V, 87
 Maiden's Blush, V, 87
 Northern Spy, V, 87
 of Peru, IV, 10
 Rambo, V, 86
 Rawles Janet, III, 34
 Red Astrachan, V, 86
 Red Romanite, V, 86
 Rome Beauty, I, 71
 Soulard, V, 87
 Summer Rose, V, 86
 Sweet June, V, 75
 Tallman's Sweet, III, 35
 Wild Crab, IV, 42, V, 87, Supp., 80
 Willow Twig, V, 87
 Winesap, IV, 45
 Yellow Bellflower, IV, 45
 Apricot, I, 30, III, 11, IV, 29, V, 86, VII, 159
 Aramon Grape, VII, 111
 Arbor vitae, I, 150, IV, 123, IX, 30
arietinum, *Cicer*, III, 105
Aristida oligostachya, VIII, 122
Aristolochia, II, 116, 118
Aristolochia serpentina, II, 116
sipho, II, 116
tomentosa, II, 116
arizonica, *Vitis*, IV, 60, VI, 73, 76
aromatica, *Rhus*, II, 58, VI, 121, IX, 6
Artemisia, II, 135, V, 35
campestris, I, 175
Asclepias, II, 58, III, 144, 167, V, 152, VIII, 61, 92, 119
cornuti, III, 144
curassavica, III, 144
phytolaccoides, III, 144
purpurascens, III, 144
tuberosa, III, 144
 Ash, III, 126, IV, 123, VII, 72, 160
 Black, VII, 160
 Mountain, I, 43, V, 86, VII, 72
 Ash-leaved Spirea, V, 86
 Asparagus, II, 113, III, 70
 Aster, I, 92, II, 113, 114, III, 105
Astragalus, Supp., 71
Atropa belladonna, IX, 4
aurantiaca, *Maclura*, IV, 100
aureum, *Ribes*, IX, 2
austriaca, *Pinus*, I, 24, V, 100
 Austrian Pine, V, 100, IX, 30, 32, 33

aviculare, *Polygonum*, Supp., 47

Azalea, IV, 126

B.

Balm of Gilead, II, 89, V, 136, VII, 160

Balsam, II, 114, V, 136

Fir, VII, 172, IX, 30

Banyan, III, 5

Baptisia, V, 136

Barberry, IV, 104, 123

Barley, I, 160, II, 23, III, 112, VII, 27, VIII, 143

Base-wood, III, 126, IV, 126

batatus, *Ipomea*, II, 56

Bayberry, IV, 123

Bean, I, 79, II, 14, III, 51, 52, 68, 131, VII, 146, Supp., 69, 70

Early Snap, I, 98

English, I, 98

String, III, 105

Windsor, I, 98, III, 51

Bear grass, V, 158

Beech, I, 121, IV, 124, 132, VII, 72

Beet, II, 113, V, 111, 114, VII, 146, 159, VIII, 23, 143

Belladonna, IV, 10

belladonna, *Atropa*, IX, 4

Bellflower, IV, 45

Ben Davis Apple, IV, 45

Benoni Apple, IV, 52, V, 87

Bermuda Sweet-potato, II, 61

Bhotan Pine, V, 100

Bignonia radicans, III, 64, VI, 87

Bind-weed, II, 10

Birch, II, 121, IV, 29, 123, 124, 124, Supp., 73

Bitternut Hickory, V, 104, 105, VII, 97

Bitter-sweet, II, 62

Black Ash, VII, 160

Blackberry, I, 70, 139, IV, 104, V, 108, 120, VI, 111, 127, VII, 159

Dorchester, VI, 113

Black Cherry, Wild, V, 132, 136

Currant, III, 105, IX, 2

July Grape, VII, 102

-gum Elm, V, 78

Hamburg Grape, VI, 76

Henbane, VI, 12

-knot, III, 25

Locust, IV, 82, 142, V, 136, VII, 160

Oak, I, 14, III, 127, V, 132, VI, 115

Prince Grape, VI, 77, 78

Spanish Alabama Grape VII, 107

Sweet Grape, VI, 79

Thorn, III, 36

Walnut, III, 125, 127, 131, IV, 82, VII, 160

blitum, *Amaranthus*, VIII, 61, 119, 121, 122, IX, 123

Blueberry, IV, 126

Blue Dyer Grape, VI, 68

Grass, II, 44, 54, 55, VIII, 27, 49, 122, 182, IX, 47, Supp., 56

Box Elder, VII, 72, 159

Brazilian Sweet-potato, II, 61

Broom-corn, V, 40, VII, 146, 159

Buckwheat, I, 79, III, 109, 141, VII, 43, 146, 159

Burdock, II, 10

Bush Grape, IV, 60, VI, 73

Butter-bean, VII, 146

-cup, II, 10

-nut, III, 68, 127, Supp., 54

C.

Cabbage, I, 79, 83, 84, 156, II, 104, 106, 107, 110, 112, 113, 114, 115, III, 11, IV, 10, 11, 35, 36, V, 111, VI, 153, VII, 47, 159, Supp., 78

californica, *Vitis*, IV, 60, VI, 73

campestris, *Artemisia*, I, 175

Canada Thistle, II, 10

canadense, *Erigeron*, II, 11, VI, 63, IX, 43

canadensis, *Abies*, I, 24

Anacharis, II, 11, IX, 43

Cercis, I, 132, III, 72, 136, Supp., 75

candicans, *Vitis*, IV, 60, VI, 73, 76

canescens, *Amorpha*, II, 90

capitatum, *Oroton*, II, 125, V, 147

Carex, VI, 138

carolinense, *Solanum*, I, 103, 107, 108, II, 105, IV, 10, VIII, 122

Carrot, VII, 146, 159, VIII, 143

Carya alba, V, 105, VII, 117, 118

amara, V, 104, VII, 118

glabra, VII, 99, 117

oliveiformis, V, 105

porcina, V, 105

Castor Bean, IV, 112, VII, 43, 146, 159

Catalpa, I, 71, 150

Catawba Grape, IV, 62, 63, V, 59, 62, 65, 72, 73, VI, 47, 75, 79, 80, 81, 83, VII, 101, 102, 110, 116

Cayenne Pepper, IV, 10

Ceanothus americanus, II, 35, VII, 48

Cedar, I, 128; II, 91, IV, 51

Red, I, 150, IV, 51, VII, 159, VIII, 119, IX, 39

Celery, VII, 146

Celtis crassifolia, VI, 137

mississippiensis, VI, 137

occidentalis, VI, 137

Cembra Pine, V, 100

Cephalanthus, IV, 123

Cerasus serotina, III, 120

Cercis canadensis, I, 132, III, 72, 136, Supp., 75

Challenge Grape, IV, 68, VI, 47

Chasselas Grape, VII, 102

Cheat, II, 10, VIII, 40, 50

Chenopodium, Supp., 78

album, II, 113, VI, 12

hybridum, VI, 12

Cherry, I, 53, 77, 150, II, 35, 96, 114, III, 11, 32, 57, 58, 120, 127, 163, IV, 39, 41, 104, V, 86, 108, 169, VI, 158, VII, 48, 72, 159, VIII, 19, Supp., 79

Black, V, 132, 136

Mahaleb, VI, 49

Mazzard, VI, 49

Morello, I, 53, VI, 49

Sour, VII, 159

Sweet, VII, 159

Wild, III, 120, IV, 123

Chest, II, 10, 55, VIII, 49

Chestnut, I, 24, II, 121, IV, 132

Horse, I, 146

Spanish, IV, 56

Chickasaw Plum, I, 53

Chickory, IV, 112

Chick-pea, III, 103

Chickweed, I, 179

Chinese Yam, VIII, 143

Choke Cherry, IV, 126, V, 136

Chufa, VIII, 143

ciadina, Massospora, Supp., 59
Cichorium sativa, I, 79
Cicer arietinum, III, 105
 Cinquefoil, III, 82
Cirsium lanceolatum, I, 180, VI, 12
 Clara Grape, VI, 79
 Clinton Grape, I, 13, 14, 30, 130, 131, II, 86, 92, III, 87, 89, 91, 92, IV, 62, 63, 64, V, 63, 64, 65, 66, 109, VI, 36, 47, 48, 67, 68, 73, 78, 79, 80, 81, 83, 84, VII, 102, 110, 111, 117
 Clover, II, 113, III, 11, 83, IV, 143, V, 136, VI, 103, VII, 146, 168, VIII, 49, Supp., 78
 Cluster Tomato, V, 118
coccifera, Quercus, VII, 96
 Cocklebur, I, 92, III, 60, 105
 Coffee-pea, III, 105
coloratum, Epilobium, VI, 90
 Columbia Plum, I, 53
communis, Ricinus, IV, 112
 Concord Grape, I, 125, 130, 131, 132, 133, II, 86, III, 72, 87, 92, IV, 62, 63, 65, V, 59, 63, 64, 65, VI, 47, 48, 75, 79, 80, 81, 83, 84, 95, VII, 102, 111, 115, 117
Convolvulus, II, 62, III, 68, IV, 136
copallina, Rhus, II, 58, VI, 119
cordata, Salix, IX, 20
cordifolia, Vitis, III, 87, 88, 89, 90, 91, IV, 60, V, 66, 118, VI, 36, 73, 74, 75, 76, VII, 96
Cordyceps ravenelii, Supp., 53
Coreopsis, II, 85
 Corn, I, 79, 80, 81, 87, 126, 154, 155, 157, 158, II, 16, 23, 27, 28, 42, 43, 44, 54, 55, 89, III, 59, 66, 104, 107, 108, 109, 111, 112, VII, 31, 38, 146, 159, 172, VIII, 25, 27, 49, 123, 143, Supp., 56, 62
 Indian, I, 92, III, 105, V, 40, 123, 136, VII, 169
 Cornucopia Grape, IV, 63, VI, 47
cornuti, Asclepias, III, 144
cornutum, Solanum, IV, 10
 Corsican Pine, V, 100
cotinus, Rhus, VI, 119
 Cotton, I, 150, II, 33, 41, III, 68, 70, 104, V, 136, VI, 17, Supp., 56
 Cottonwood, I, 24, 178, II, 119, VII, 160, IX, 127
 Cow-cockle, II, 10
 Crab-apple, I, 43, 65, III, 25, 30, 31, 40, IV, 89, 42, 52, V, 86, 87
 Transcendent, I, 15
 Crab-grass, III, 111
 Cranberry, Supp., 82
crassifolia, Celtis, VI, 137
Crataegus, IV, 42, Supp., 80
 tomentosa, III, 36
 Creeper, I, 132
 Trumpet, III, 64, VI, 87
 Virginia, II, 78, 86, III, 77, VI, 88
Orepis, Supp., 78
 Creveling Grape, I, 72, IV, 63, V, 65, VI, 47, 80
Oroton capitatum, II, 125, V, 147
 monanthogynum, V, 147
 Croton Grape, V, 59
 Cucumber, II, 64, 66, 67, 68, 69, 70, III, 111
 Cucurbitaceous vines, II, 64, 66, VII, 159
 Cunninghamham Grape, IV, 62, 63, V, 64, 65, VI, 47, 48, 78, 81, VII, 96, 111, 115, 117, VIII, 167
curassavica, Asclepias, III, 144
 Currant, I, 15, 70, 79, 140, II, 9, 96, III, 68, IV, 104, V, 51, 86, 136, VI, 12, 46, 111, VIII, 121, IX, 1, 2, 3, 5, 7, 25

Currant, Black, III, 105, IX, 2
 Fetid, IX, 2
 Golden, IX, 2
 Missouri, IX, 2
 Red, II, 8, 9, VI, 12, IX, 2
 -flowered, IX, 2
 White, IX, 2
Cynoglossum officinale, V, 101
 Cythiana Grape, IV, 61, 63, 64, V, 64, 65, VI, 47, 74, VII, 111, 115
Cyperus esculentus, VIII, 143
 Cypress vine, I, 80

D.

Dahlia, I, 92, II, 114, III, 105
 Damson, V, 119
 Dandelion, IV, 143, Supp., 78
Datura, I, 107, IV, 10
 stramonium, V, 56
decandra, Phytolacca, VIII, 122
decapetalus, Helianthus, IV, 142
 Delaware Grape, I, 130, II, 92, III, 87, IV, 63, V, 59, 63, 65, 66, 111, VI, 47, 73, 80, 81, 83, 84, VII, 106, 110, 116
Delphinium, VII, 185
 Devereux Grape, V, 65
 Diana Grape, IV, 63, V, 59, 65, VI, 47, VII, 96
Dipsacus, IV, 112
discolor, Solanum, IV, 10
 Dogbane, III, 144, VIII, 119
 Dog-fennel, II, 10, IV, 15
 Dogwood, V, 84, 92, 136
 Doolittle Raspberry, VI, 111
 Dorchester Blackberry, VI, 113
 Dracut Grape, IV, 63
 Amber Grape, VI, 47, 48
Dryas octopetala, I, 143
 Duane's Early Plum, IV, 142
 Duc de Malacoff Grape, IV, 64
 Duchesse Pear, III, 36
 Dutchman's Pipe, II, 116
 Dwarf Apple, I, 69, 70
 Pear, I, 128
 Sumach, VI, 119

E.

Early Goodrich Potato, I, 110, III, 101, V, 51
 Harvest Apple, V, 66
 Rose Potato, IV, 11
 Snap Bean, I, 98
Echinopspermum strictum, V, 52
 Egg Plant, I, 103, 108, IV, 10
 Elder, III, 100, 101, IV, 104, V, 40
 Elderberry, IV, 104
eleagnifolium, Solanum, Supp., 54
 Elm, I, 123, 146, II, 95, 96, 98, 121, III, 73, 127, IV, 104, 126, 129, V, 86, 93, 94, 104, 138, VI, 29, VII, 83, 85, 160, VIII, 19, IX, 127
 White, I, 123
 Elsimboro Grape, IV, 64
Empusa musca, IV, 88
 Endive, Wild, I, 79, 83
Engelmannia, V, 147
 English Gooseberry, IV, 56, V, 70
 Hawthorn, V, 70
Entomophila, V, 152
Epilobium coloratum, VI, 90

Eragrostis poaeoides, VIII, 122
Erigeron canadense, II, II, VI, 63, IX, 43
Erysiphe, V, 70
esculentus, *Cyperus*, VIII, 143
Eucalyptus globulus, VI, 55
 Eumelan Grape, V, 65, VII, 101
Eupatorium perfoliatum, VI, 12
 scrobinum, I, 152
 European Grape, IV, 55, 63, VI, 47, 77
 Larch, VII, 172
 Rulander Grape, VI, 77, 78
excelsa, *Pinus*, V, 100

F.

falcata, *Quercus*, VIII, 182
 False Indigo, II, 132, V, 136
fasciculata, *Vernonia*, I, 153
 Fetid Currant, IX, 2
 Field Garlic, II, 10
 Figwort family, VII, 14
filamentosa, *Yucca*, V, 158, 159, VIII, 171
 Fir, IX, 29
 Balsam, VII, 172, IX, 30
floccida, *Yucca*, V, 159
 Flax, II, 42, VII, 42, 159, VIII, 25
floridum, *Ribes*, IX, 2
 Foment Grape, V, 66
 Fox Grape, VI, 75, 84
 Fox-tail Grass, II, 10
 Fragrant Sumach, VI, 121, IX, 6
 French Hazel, VI, 121
 Frost Grape, III, 87, 89, 90, IV, 60, VI, 73
fruticosa, *Amorpha*, II, 132, V, 136
 Fungus infesting Cicada, I, 26
 White Grub, I, 158, VI, 123, 125

Furze, III, 51

G.

Garden Gooseberry, IX, 2
 Garlic, Field, II, 10
 Garrigues Grape, VI, 84
 Geranium, III, 68
glabra, *Carya*, VII, 99, 117
 Photinia, IV, 132
 Rhus, II, 58, VI, 119
 Gladiolus, III, 105
glandulosa, *Ailanthus*, IV, 113, 120
glauca, *Yucca*, V, 153
globulus, *Eucalyptus*, VI, 55
gloriosa, *Yucca*, V, 159, VIII, 171
 Goat-weed, II, 125, V, 147
 Goethe Grape, IV, 63, V, 62, 64, 65, 66, VI, 47, 80, 81,
 VII, 96, 111, 116
 Golden Chasselas Grape, VI, 77
 Clinton Grape, III, 87, VI, 47, 48, 68, VII, 102
 Currant, IX, 2
 -rod, I, 98, 152, 173, II, 134, IV, 28, Supp., 57
 Willow, III, 168
 Gooseberry, I, 140, II, 8, 9, III, 58, 68, VI, 46, VIII,
 121, IX, 1, 2, 3, 5, 6, 8, 26
 Gooseberry, English, IV, 56, V, 70
 Garden, IX, 2
 Houghton's Seedling, I, 140
 Showy, IX, 2
 Goosefoot, II, 113, VI, 12
 Gourd, II, 66

Grape, Agawam, V, 65
 Alvey, IV, 63, V, 65, VI, 47, VII, 102
 Amber, VI, 47, 48
 Aramon, VII, 111
 Black Hamburg, IV, 56, VI, 76
 July, VII, 102
 Prince, VI, 77, 78
 Spanish Alabama, VII, 107
 Sweet, VI, 79
 Blue Dyer, VI, 68
 Bullet, IV, 62, VI, 75
 Bush, IV, 60, VI, 73
 Catawba, IV, 62, 63, V, 59, 62, 65, 72, 73, VI,
 47, 75, 79, 80, 81, 83, VII, 101, 102, 110, 116
 Challenge, IV, 63, VI, 47
 Chasselas, IV, 56, VII, 102
 Clara, VI, 79
 Clinton, I, 13, 14, 30, 130, 131, II, 86, 92, III,
 87, 89, 91, 92, IV, 62, 63, 64, V, 63, 64, 65, 66,
 109, VI, 36, 47, 48, 67, 68, 73, 78, 79, 80, 81, 83,
 84, VII, 102, 110, 111, 117
 Concord, I, 125, 130, 131, 132, 133, II, 86, III,
 72, 87, 92, IV, 62, 63, 65, V, 59, 63, 64, 65, VI,
 47, 48, 75, 79, 80, 81, 83, 84, 95, VII, 102, 111,
 115, 117
 Cornucopia, IV, 63, VI, 47
 Creveling, I, 72, IV, 63, V, 65, VI, 47, 80
 Croton, V, 58
 Cunningham, IV, 62, 63, V, 64, 65, VI, 47, 48,
 78, 81, VII, 96, 111, 115, 117, VIII, 167
 Cynthiana, IV, 61, 63, 64, V, 64, 65, VI, 47, 74,
 VII, 111, 115
 Delaware, I, 130, II, 92, III, 83, 87, IV, 63, V,
 59, 63, 65, 66, 111, VI, 47, 73, 80, 81, 83, 84,
 VII, 106, 110, 116
 Devereux, V, 65
 Diana, IV, 63, V, 59, 65, VI, 47, VII, 96
 Dracut, VI, 47, 48
 Amber, IV, 63
 Duc de Malacoff, IV, 64
 Elsainboro, IV, 64
 Eumelan, V, 65, VII, 101
 European, IV, 55, 63, VI, 47, 77
 Rulander, VI, 77, 78
 Foment, V, 66
 Fox, VI, 75, 84
 Frost, III, 87, 89, 90, IV, 60, VI, 73
 Garrigues, VI, 84
 Goethe, IV, 63, V, 62, 64, 65, 66, VI, 47, 80, 81,
 VII, 96, 111, 116
 Golden Chasselas, VI, 77
 Clinton, III, 87, VI, 47, 48, 68, VII,
 102
 Hamburg, V, 59
 Hartford, III, 72, IV, 63, VI, 47
 Prolific, I, 125, 130, 131, IV, 62, 64,
 65, V, 65, VI, 75, 81, VII, 116
 Herbement, IV, 61, 62, 63, 64, V, 63, 64, 65, VI,
 36, 47, 48, 74, 78, 80, 81, VII, 102, 109, 111,
 115, 117, VIII, 167
 Hermann, V, 65, VII, 111
 Huntington, III, 87
 Iona, III, 72, V, 59, 62, 65, VI, 48, 79, 80, 81, 83,
 VII, 96, 116
 Isabella, I, 130, II, 81, IV, 62, 63, 64, V, 59, VI,
 48, 75, 81, VII, 96, 101, 102

Grape, *Israella*, III, 72

Ives, IV, 63, V, 65, VI, 48, 81, 84, VII, 96, 111, 116

Seedling, I, 133, V, 64, VI, 79, 80

Jacques, V, 66, VII, 107, 117, VIII, 167

Lenoir, IV, 64, V, 66, VII, 108, 117

Lindley, V, 65

Long, V, 66

Longworth's Ohio, VII, 107

Louisiana, IV, 63, V, 65, VI, 47

Madam Pince, IV, 64

Madeira, V, 63

Malaga, VI, 78

Malvasia, VI, 77

Marion, VI, 47, 48, 68

Martha, IV, 62, 63, VI, 48, VII, 96, 111

Massasoit, V, 65

Maxatawney, IV, 63, 64, V, 65, VI, 48, 80, 81, VII, 96, 116

Merrimac, V, 65

Muscadine, IV, 60, 62, 63, VI, 72

Muscat, VII, 102

Hamburg, IV, 64

Mustang, IV, 60, 62, 64, VI, 73, 76, VIII, 167

North Carolina, III, 72, IV, 63, V, 64, VI, 48, VII, 96, 111

Northern Fox, III, 87, 90, IV, 60, 63, VI, 47, 72, 75, VII, 106

Muscadine, VI, 48, VII, 102

Norton's, V, 65, VI, 78, 84

Catawba, VIII, 96

Virginia, I, 132, IV, 62, 63, 64, VI, 47, 80, 81, VII, 109, 111, 115

Ohio, VII, 107

Othello, IV, 63, VI, 47

Pauline, IV, 64, VII, 102

Post Oak, VI, 79

Rebecca, V, 59, VI, 48

Rent, V, 64, VI, 81, VII, 115

River Bank, IV, 60, 63, V, 116, 117, VI, 36, 47

Riverside, VI, 72

Rogers, I, 130, V, 66

Hybrid, I, 130, V, 117, VI, 80

No. 4, I, 130, II, 92

Rulander, V, 65, VI, 47, 80, VII, 111

European, VI, 77, 78

Salem, V, 65, 66, VI, 48, 79

Sand, IV, 60, VI, 73

Scagey, V, 66

Scuppernong, III, 77, IV, 62, 64, VI, 50, 76, VII, 106

Segar Box, VII, 107

Sonora, IV, 64

Southern Fox, III, 77, IV, 60, 62, 63, VI, 48, 72, 75

St. Augustine, V, 63

Sugar, IV, 61

Summer, III, 89, 90, IV, 60, 63, VI, 47, 72

Taylor, I, 30, II, 86, III, 87, IV, 63, 64, V, 63, 65, 66, VI, 36, 47, 48, 68, 80, 95, VII, 102, 115

Bullet, VI, 73

Telegraph, V, 65, VI, 47, VII, 106

Tinto, VI, 36

Tokay, V, 66

Venango, VI, 84

Grape, Virginia Seedling, VI, 61, 74

Walter, V, 59, 62, VI, 80

Warren, VII, 102

Weehawken, V, 59

White Riesling, VII, 102

Scotch Cluster, VI, 77

Wilder, IV, 63, V, 62, 63, VI, 48, 81, VII, 101, 102, 111, 116

Winter, IV, 60, VI, 73

York Madeira, IV, 64, V, 64

Grape Mildew, IX, 43

-vine, I, 30, 70, 72, 78, 80, 124, 128, 129, 131, 132, 133, 136, 137, 138, 180, II, 71, 74, 76, 78, 81, 82, 83, 85, 86, 87, 88, 89, 91, 92, III, 11, 61, 63, 65, 68, 70, 72, 75, 77, 79, 81, 84, 111, 130, 137, 141, IV, 52, 54, 55, V, 54, 57, 108, 112, 114, 116, 117, 118, 120, VI, 80, 87, 88, 91, 95, 111, VII, 47, 91, 146, 159, 172, VIII, 121, 123, 157, Supp., 75

disease, IV, 55, VI, 58, 65

-vines, American, Classification of, VI, 70

in Europe, IV, 62, V, 65,

VII, 116, VIII, 167

of the United States, The true, IV, 60, VI, 70

rooting of, V, 65

Varieties to graft, VI, 81

use as stock in grafting, VII, 115

Green Citron Melon, II, 69

Greengage Plum, I, 140

grossularia, *Ribes*, IX, 2

Ground-cherry, I, 107, IV, 10

Gympson-weed, I, 107

H.

Hackberry, V, 119, VI, 137

Hackmatack, VII, 169

Halesia, IV, 123

Hamamelis, III, 120

Hamburg Grape, V, 59

Hard Maple, III, 126, Supp., 55

Harrison Potato, I, 110

Hartford Grape, III, 72, IV, 63, VI, 47

Prolific Grape, I, 125, 130, 131, IV, 62, 64, 65, V, 65, VI, 75, 81, VII, 116

Haw, I, 108, III, 25, 32, 35, 38, 92, V, 51

Hawthorn, I, 43, III, 36

English, V, 70

Hazel, III, 11, 37, 75, IV, 104, 126, V, 132

French, VI, 121

Heart Cherry, VIII, 121

-shaped Willow, IX, 20

Hedge-mustard, VI, 12

Helianthus, VII, 159, Supp., 53

decapetalus, IV, 142

petiolaris, V, 52

tuberosus, VIII, 143

Hellebore, White, IX, 13

Hemp, III, 105, VII, 42, 146

Henbane, IV, 10

Herbmont Grape, IV, 61, 62, 63, 64, V, 63, 64, 65, VI, 36, 47, 48, 74, 78, 80, 81, VII, 102, 109, 111, 115, 117,

VIII, 167

Herds-grass, VII, 168

Hermann Grape, V, 65, VII, 111
Hibiscus militaris, VI, 92
 Hickory, I, 126, 153, 154, III, 37, 124, 126, 127, 131, 135,
 IV, 42, 43, 52, 54, 104, 124, 126, 140, V, 104,
 119, VI, 64, 101, VII, 160, Supp., 81
 Bitternut, V, 104, 105, VII, 97
 Pecan, V, 105
 Pignut, V, 105
 Shagbark, II, 33, IV, 54
 Shellbark, IV, 66, V, 103, 105
 Honey-locust, I, 92, 150, III, 45, IV, 104, 126, VII, 159
 -suckle, II, 113
 Hop-plantain, III, 131
 -vine, V, 136
 Horse Chestnut, I, 146
 Gentian, III, 134
 -nettle, I, 103, 104, 107, 108, IV, 10
 Weed, II, 11, IX, 43
 Houghton's Seedling Gooseberry, I, 140
 Hound's-tongue, V, 101
humilis, *Salix*, V, 132
 Hungarian Grass, VII, 27, 23, VIII, 29, 39
 Huntington Grape, III, 87
hybridum, *Oenopodium*, VI, 12
hydropiper, *Polygonum*, III, 70, VI, 12
Hyoscyamus, IV, 10
 -niger, VI, 12

I.

incana, *Quercus*, IV, 114
 Indian Corn. (See Potato.)
 Indigo, V, 136
 False, II, 132, V, 136
insectoria, *Quercus*, V, 18
 Iona Grape, III, 72, V, 59, 62, 65, VI, 48, 79, 80, 81, 83,
 VII, 96, 116
Ipomea, III, 45
 -batatus, II, 56
 Irish Potato. (See Potato.)
 Ironweed, V, 136
 Isabella Grape, I, 130, II, 81, III, 72, IV, 62, 63, 64, V,
 59, VI, 48, 75, 81, VII, 96, 101, 102
 Israella Grape, III, 72
 Ives Grape, IV, 63, V, 65, VI, 48, 81, 84, VII, 96, 111,
 116
 Seedling Grape, I, 133, V, 64, VI, 79, 80
 Ivy, Poison, VI, 121

J.

Jamestown Weed, I, 107, II, 10, V, 56
 Japan Varnish tree, IV, 120
 Jaques Grape, V, 66, VII, 107, 117, VIII, 167
 Jerusalem Artichoke, VIII, 143
jujuba, *Rhamnus*, IV, 138
 Jujube, V, 18
 June-berry, I, 43
Juniperus virginiana, I, 24

K.

King of the Earlies Potato, IV, 11
 Knotweed, Supp., 47
 Kolrabi, VII, 159
 Kunogi, IV, 130, 134, 136

L.

labrusca, *Vitis*, III, 87, 89, 90, IV, 60, 63, V, 60, 65, 66,
 118, VI, 36, 47, 48, 71, 72, 74, 75, 76, VII, 103

Laburnum, IV, 118
 Lamb's quarter, II, 10, 113, VI, 12
lanceolatum, *Cirsium*, I, 180, VI, 12
 Larch, European, VII, 172
laricio, *Pinus*, V, 100
Lathyrus, III, 52
 Laurel, V, 33
 -cherry, V, 33
 -leaved oak, IV, 134
 Lawrence Pear, III, 36
 Lenoir Grape, IV, 64, V, 66, VII, 108, 117
 Lettuce, IV, 100, 112, VI, 158
 Lilac, III, 68, IV, 104, 123, VII, 159
 Persian, I, 15, V, 70, 86, 127
 Lima Bean, VII, 172
 Limber Twig Apple, V, 87
linceumii, *Vitis*, VI, 74
 Linden, I, 150, V, 93, VII, 72
Lindera, II, 121, IV, 123
 Lindley Grape, V, 65
Liquidambar, IV, 123
Liriodendron, IV, 123
 -tulipifera, Supp., 55
 Live-oak, IV, 129
 Locust, I, 24
 Black, IV, 82, 142, V, 136, VII, 160
 Honey, I, 98, 150, III, 45, IV, 104, 126, VII, 159
 Lombardy Poplar, I, 150, 157, II, 89, VII, 160
 Long Grape, V, 66
 Longworth's Ohio Grape, VII, 107
 Louisiana Grape, IV, 63, V, 65, VI, 47
 Lowell Apple, V, 87
 Lucern, III, 83, 105
Lycopersicum, IV, 10

M.

Maclura aurantiaca, IV, 100
 Madam Pince Grape, IV, 64
 Madeira Grape, V, 63
Madia sativa, VI, 55
 Mahaleb Cherry, VI, 49
 Maiden's Blush Apple, V, 87
 Malaga Grape, VI, 78
 Mallow, VI, 89
Malva, VI, 89
 -sylvestris, VIII, 182
 Malvasia Grape, VI, 77
 Mandrake, IV, 15
 Mangel wurzel, VIII, 143
 Maple, I, 47, 146, 150, II, 121, IV, 104, 123, 126, VI, 107,
 111, VII, 160
 Hard, III, 126, Supp., 55
 Silver, I, 150, V, 137
 Soft, I, 47, 150, IV, 42, V, 120, 137, VI, 106,
 Supp., 55, 62, 74
 Mare's Tail, II, 11
 Marigold, II, 114
 Marion Grape, VI, 47, 48, 68
 Martha Grape, IV, 62, 63, VI, 48, VII, 96, 111
Maruta, VIII, 100
Massospora cicadina, Supp., 59
 Massasoit Grape, V, 65
 Maxatawny Grape, IV, 63, 64, V, 65, VI, 48, 80, 81,
 VII, 96, 116
 May Apple, IV, 15
 -weed, II, 10

Mazzard Cherry, VI, 49
 Meadow-sweet, III, 51
media, *Stellaria*, I, 179
 Medlar, V, 86
 Neapolitan, IV, 132
 Melon, II, 64, 66, 69, 70
 Alton Large Nutmeg, II, 69
 Green Citron, II, 69
 Merrimac Grape, V, 65
 Mignonette, II, 113
miktaris, *Hibiscus*, VI, 92
 Milkweed, I, 139, II, 58, III, 133, 144, 168, VIII, 61, 92, 119
 Miner Plum, I, 53
mississippiensis, *Celtis*, VI, 187
 Missouri Currant, IX, 2
missouriensis, *Solidago*, I, 174
mitis, *Pinus*, V, 100
monanthogynum, *Croton*, V, 147
monilifera, *Populus*, II, 119
monica, *Strombocarpa*, I, 65
monticola, *Vitis*, VI, 57, 74
 Morello Cherry, I, 53, VI, 49
moretti, *Morus*, IV, 100
 Morning Glory, I, 100, II, 62
Morus alba, IV, 100
 moretti, IV, 100
 multicaulis, IV, 80, 100
 rubra, IV, 100
 Mountain Ash, I, 43, V, 86, VII, 72
 Mulberry, IV, 74, 75, 76, 79, 82, 100
 Red, IV, 100
 White, I, 72, 73
 Mullein, II, 10, V, 35, VII, 14
multicaulis, *Morus*, IV, 80, 100
 Muscardine Grape, IV, 60, 62, 63, VI, 72
musca, *Empusa*, IV, 88
 Muscardine, IV, 88, 89, 91, 144
 Muscat Grape, VII, 102
 Hamburg Grape, IV, 64
 Mustang Grape, IV, 60, 62, 64, VI, 73, 76, VIII, 167
mustangensis, *Vitis*, IV, 62, VI, 76
 Mustard, IV, 36, V, 112
 Hedge, VI, 12
 Myrica, IV, 123

N.

Nansemond Sweet-potato, II, 61
 Neapolitan Medlar, IV, 132
 Neck-weed, II, 35, VII, 48
 Nectarine, III, 40
memoralis, *Solidago*, I, 173
 Nettle, II, 103, IV, 10, VIII, 122
 Horse, I, 103, 104, 107, 108, IV, 10
 New Jersey Tea-plant, II, 35, VII, 48
Nicandra, IV, 10
Nicotiana, IV, 10
niger, *Hyoscyamus*, VI, 12
 Nightshade, IV, 10, VI, 12
nigrum, *Ribes*, IX, 2
 Solanum, VI, 12
 North Carolina Grape, III, 72, IV, 63, V, 64, VI, 48, VII, 96, 111
 Northern Fox Grape, III, 87, 90, IV, 60, 63, VI, 47, 72, 75, VII, 106
 Muscadine Grape, VI, 48, VII, 102
 Spy Apple, V, 87

Norton's Grape, V, 65, VI, 78, 84, VII, 96
 Virginia Grape, I, 132, IV, 62, 63, 64, VI, 47, 80, 81, VII, 109, 111, 115
 Norway Spruce, I, 150, VII, 172, VIII, 119, IX, 30
novaboracensis, *Vernonia*, VIII, 119

O.

Oak, I, 47, 126, 128, 139, 146, II, 91, III, 73, 94, 124, 125, 126, 127, 131, 134, 138, IV, 45, 52, 114, 126, 137, 140, V, 18, 126, 127, 132, 139, VI, 103, 113, 127, 128, 158, 166, VII, 72, VIII, 23, IX, 52
 Black, I, 14, V, 132, VI, 115
 Chermes, VII, 96
 Laurel-leaved, IV, 134
 Live, IV, 129
 Pin, I, 157
 Post, I, 157, IV, 42, 66, 134, V, 132, VI, 64, 115, VII, 97
 Red, I, 14, V, 132, VI, 115
 White, VI, 64, 115
 Oat, I, 88, II, 16, 44, 54, III, 111, 112, 115, VI, 12, VII, 38, 146, VIII, 27, 49, 119
occidentalis, *Celtis*, VI, 137
 Thuja, I, 24
octopetala, *Dryas*, I, 143
officinale, *Sisymbrium*, VI, 12
 Ohio Grape, VII, 107
Oidium tuckeri, V, 57, 70, VI, 30, 63, 79, 85, IX, 43
 Proof of its occurrence in America, V, 70
oligostachya, *Aristida*, VIII, 122
olivaformis, *Carya*, V, 105
 Onion, II, 9, VII, 159, 169, VIII, 49
 Osage Orange, I, 126, 150, II, 89, III, 131, IV, 75, 79, 100, VII, 159, IX, 95, Supp., 69
 Othello Grape, IV, 63, VI, 67
 Ox-eye Daisy, II, 10

P.

Panicum sanguinale, VIII, 122
 Parsnip, VII, 146, VIII, 119, 143
 Pauline Grape, IV, 64, VII, 102
 Pea, II, 14, 42, III, 44, 50, 68, 105, 107, VIII, 25, 119
 Chick, III, 105
 Coffee, III, 105
 Peach, I, 47, 50, 77, II, 15, III, 15, 37, 30, 34, 38, 40, 57, 103, 105, 114, 120, 127, 132, 134, IV, 22, 29, 40, 52, 82, V, 108, 120, 127, 129, VI, 112, VII, 72, 146, 159, VIII, 19, Supp., 75
 blow Potato, I, 79, 98, 99, III, 101
 Rot, I, 52
 Peanut, VII, 146
 Pear, I, 15, 43, 64, 69, 70, 77, 128, 146, 150, II, 33, 38, 114, III, 11, 33, 36, 38, 57, 78, 120, 131, IV, 40, 52, 104, V, 54, 86, 93, 122, VII, 72, 146, 159, VIII, 24
 blight, III, 58, VIII, 24
 Duchess, III, 36
 Dwarf, I, 128
 Lawrence, III, 35
 Seckel, III, 35
 Standard, I, 128
 White Doyenne, I, 15
 Pecan, V, 105, VI, 101
peltatum, *Podophyllum*, IV, 15
peregrina, *Veronica*, II, 35, VII, 48

- perfoliatum*, *Eupatorium*, VI, 12
Triosteum, III, 134
- Peronospora*, V, 70, VI, 85
- Persian Cantelope, II, 69
 Lilac, I, 15, V, 70, 86, 127
- Persimmon, V, 69, 109
- petiolaris*, *Helianthus*, V, 52
- Petunia, IV, 10
- Phaseolus*, III, 52, 53
- Photinia glabra*, IV, 132
- Physalis*, I, 107, IV, 10
- Phytolacca decandra*, VIII, 122
- phytolaccoides*, *Asclepias*, III, 144
- Pig-nut Hickory, V, 105
 -weed, V, 52, VI, 12
- Pimpinel, IV, 118
- Pine, I, 24, 127, II, 15, 91, V, 100, IX, 29, 32
 Austrian, V, 100, IX, 30, 32, 33
 Bhotan, V, 100
 Cembra, V, 100
 Corsican, V, 100
 Pitch, V, 100, IX, 32
 Pyrenaian, V, 100
 Scotch, III, 92, V, 100, IX, 30, 32, 33
 White, III, 92, V, 97, 100, 102, IX, 13, 29, 30, 32
 Yellow, V, 100
- Pin Oak, I, 157
- Pinus austriaca*, I, 24, V, 100
cembra, V, 100
exoclea, V, 100
laricio, V, 100
mitis, V, 100
pumilio, V, 100
pyrenaica, V, 100
resinosa, V, 100
strobus, I, 24
sylvestris, I, 24, V, 100
- Pitch Pine, V, 100, IX, 32
- Plantago*, IV, 142
- Plantain, II, 10, III, 68, IV, 142, 143
- Plum, I, 15, 65, 140, 146, 150, II, 15, 96, III, 11, 25, 27,
 32, 34, 40, 41, 57, 103, 120, 127, 153, 163, IV, 23]
 29, 39, 41, 104, 118, 123, 124, 126, V, 86, 93, 109
 VI, 127, 141, VII, 72, 159, IX, 2
- Chickasaw, I, 53
- Columbia, I, 53
- Duane's Early, IV, 142
- Greengage, I, 140
- Miner, I, 53
- Wild, I, 15, 55
- poaeoides*, *Eragrostis*, VIII, 122
- Podophyllum peltatum*, IV, 15
- Poison Ivy, VI, 121
- Pokeweed, VIII, 122
- Poke Milk-weed, III, 144
- Polecat-weed, VI, 121
- Polygonum aviculare*, Supp., 47
hydropiper, III, 70, VI, 12
- Poplar, II, 91, III, 72, 73, 120, 137, 135, 153, 163, IV,
 123, 126, V, 136, VI, 105
- Lombardy, I, 150, 157, II, 89, VII, 160
- Silver, III, 156, 168
- Silver-leaf, VII, 160
- Populus monilifera*, II, 119
- orcina*, *Carya*, V, 105
- Post Oak, I, 157, IV, 42, 66, 134, V, 132, VI, 64, 115,
 VII, 97
- Post Oak Grape, VI, 79.
- Potato, I, 91, 93, 95, 96, 97, 98, 99, 100, 101, 158, II,
 42, 56, 57, 70, 114, III, 98, 105, 111, IV, 5,
 10, 11, V, 18, 111, 112, 114, VI, 11, VII, 2, 47,
 146, 159, 169, 172, VIII, 1, 25, 37, 119, IX,
 39
- Chili No. 2, III, 101
- Early Goodrich, I, 100, III, 101, V, 51
 Rose, III, 101, IV, 11
- Harrison, I, 110
- King of the Earlies, IV, 11
- Mercer, III, 101
- Peach-blow, I, 97, 98, 99, III, 101
- Peerless, III, 101
- Pink-eye, III, 101
- Quaker Russet, I, 98
- Russet, III, 101
- Shaker, III, 101
- Potentilla*, III, 82
verna, I, 143
- Poterium sanguisorba*, I, 143
- Prickly Mesquit Grass, VII, 192
- Prostrate Currant, IX, 2
- prostratum*, *Ribes*, IX, 2
- Prune, III, 40
- Prunus*, VI, 141
americana, I, 15
lauro-cerasus, V, 33
serotina, V, 136
- puberula*, *Fuca*, V, 153
- pumilio*, *Pinus*, V, 100
- Pumpkin, I, 79, II, 42, III, 105, VIII, 25
- Purple-fringe, VI, 119
- purpurascens*, *Asclepias*, III, 144
- Purslane, II, 10, III, 112, 141, V, 69, VI, 158, VII,
 46, 47, VIII, 122, 123
- Speedwell, II, 85, VII, 48
- Pyrenaian Pine V, 100
- pyrenaica*, *Pinus*, V, 100
- Q.**
- Quaker Russet Potato, I, 98
- Quercus coccifera*, VII, 96
falcata, VIII, 182
incana, IV, 114
infectoria, V, 18
serrata, IV, 130
- Quince, I, 43, 65, 150, II, 35, 114, III, 30, 35, 36, 38,
 IV, 39, 41, 126, 132, VII, 48, Supp., 79
- quinquefolia*, *Ampelopsis*, I, 132, II, 74
- R.**
- racemosus*, *Symphoricarpos*, II, 113
- radicans*, *Bignonia*, III, 64, VI, 87
- Radish, I, 156, IV, 36, V, 111, VII, 159
- Rambo Apple, V, 86
- Raspberry, I, 70, 139, II, 34, III, 72, V, 120, 122,
 VI, 111, VII, 48
- Doolittle, VI, 111
- ravenelii*, *Oordyceps*, Supp., 53
- Rawles Janet Apple, III, 34
- Rebecca Grape, V, 59, VI, 48

- Red Astrachan Apple, V, 86
 Bud, III, 72
 Cedar, I, 150, IV, 51, VII, 159, VIII, 119, IX, 30
 Currant, II, 8, 9, VI, 12, IX, 2
 -flowered Currant, IX, 2
 June Apple, IV, 52
 Mulberry, IV, 100
 Oak, I, 14, V, 132, VI, 115
 Pine, V, 100
 Romanite Apple, V, 86
 -root, II, 35, IV, 104, VII, 48
 Rentz Grape, V, 64, VI, 81, VII, 115
resinosa, Pinus, V, 100
retroflexus, *Amaranthus*, VI, 12
Rhamnus jugubæ, IV, 138
 Rhubarb, II, 123, III, 51
Rhus aromatica, II, 58, VI, 121, IX, 6
 copallina, II, 58, VI, 119
 coriaria, IV, 118
 cotinifolia, VI, 119
 glabra, II, 58, VI, 119
 toxicodendron, V, 127, VI, 121
 typhina, VI, 19
Ribes aureum, IX, 2
 aurum, IX, 2
 grossularia, IX, 2
 nigrum, IX, 2
 prostratum, IX, 2
 rubrum, IX, 2
 sanguineum, IX, 2
 speciosum, IX, 2
Ricinus communis, IV, 112
riparia, Vitis, IV, 60, 61, 63, V, 62, 65, 116, 118, VI, 36, 47, 48, 58, 72, 73, 74, 75, 95, VII, 96
 River Bank Grape, IV, 60, 63, V, 116, 117, VI, 36, 47
 Riverside Grape, VI, 72
robustum, *Solanum*, IV, 10
 Rogers' Grape, I, 30, II, 92, V, 66
 Hybrid Grape, I, 30, V, 117, VI, 80
 Rome Beauty Apple, I, 71
Rosaceæ, V, 86
 Rose, I, 70, 146, III, 120, 124, 127, IV, 126, V, 109, 123, 127, VI, 127, VII, 159, Supp., 57
 Wild, V, 126
rostratum, *Solanum*, I, 102, 108, IV, 10, VII, 1
rubra, *Morus*, IV, 100
rubrum, *Ribes*, IX, 2
Rubus, V, 154, VI, 113, Supp., 72
 Rulander European Grape, VI, 77, 78
 Grape, V, 65, VI, 47, 48, VII, 111
rupestris, Vitis, IV, 60, VI, 73, 74
rupicola, *Yucca*, V, 157
 Russet Potato, III, 101
 Rutabaga, II, 113, VII, 159, VIII, 143
 Rye, I, 160, II, 29, 44, 51, III, 111, VII, 38, 146, 168, VIII, 27, 49, IX, 51
- S.
- saccharinum*, *Acer*, IV, 108
 Salem Grape, V, 65, 66, VI, 48, 79
Salix, VI, 136
 cordata, IX, 20
 humilis, V, 132
Salvia trichostemmoides, VIII, 119
 Sand Bur, VIII, 9, 122
 Grape, IV, 60, VI, 73
sanguinale, *Panicum*, VIII, 122
sanguineum, *Ribes*, IX, 2
sanguisorba, *Poterium*, I, 143
Sarracenia, III, 153
 Sassafras, IV, 123, V, 122, 134, 136, VI, 127
sativa, *Cichorium*, I, 79
 Madia, VI, 55
scandens, *Senecio*, Supp., 78
 Scegety Grape, V, 66
 Scotch Pine, III, 92, V, 100, IX, 30, 32, 33
 Screw-bean, I, 65
 Scrub Oak, III, 163
 Willow, II, 90, III, 168, V, 132
 Scuppernong Grape, III, 77, IV, 62, 64, VI, 50, 76, VII, 106
 Seckel Pear, III, 36
 Segar-box Grape, VII, 107
Senecio scandens, Supp., 78
serotina, *Cerasus*, III, 120
 Prunus, V, 136
serotinum, *Eupatorium*, I, 152
serpentina, *Aristolochia*, II, 116
serrata, *Quercus*, IV, 130
serrulata, *Alnus*, III, 80
sesquipedale, *Angræcum*, V, 153
setigera, *Stipa*, VII, 192
 Shag-bark Hickory, II, 33, IV, 54, VII, 48
 Shaker Potato, III, 101
 Shell-bark Hickory, IV, 66, V, 103, 105
 Shepherd's Purse, II, 10
 Showy Gooseberry, IX, 2
sieglings, *Solanum*, IV, 10
 Silkweed, III, 144
 Silver Maple, I, 150, V, 137
 Poplar, III, 156, 168
 -leaf Poplar, VII, 160
sipho, *Aristolochia*, II, 116
Sisymbrium officinale, VI, 12
 Smartweed, II, 10, III, 68, 70, VI, 12
 Smoke-tree, VI, 121
 Smooth Sumach, VI, 119
 Snowberry, I, 153, 154, II, 113, Supp., 81, 82
 Snowdrop-tree, IV, 123
 Soft Maple, I, 47, 150, IV, 42, V, 120, 137, VI, 108, Supp., 55, 62, 74
Solanaceæ, IV, 10, VII, 146
Solanum carolinense, I, 103, 107, 108, II, 105, IV, 10, VIII, 122
 cornutum, IV, 10
 discolor, IV, 10
 eleagnifolium, Supp., 54
 nigrum, VI, 12
 robustum, IV, 10
 rostratum, I, 102, 108, IV, 10, VII, 1, VIII, 9, 10, 122
 sieglings, IV, 10
 tuberosum, II, 56, VIII, 9
 varsewiczii, IV, 10
Solidago, V, 154
 missouriensis, I, 174
 memoralis, I, 173
 Sonora Grape, IV, 64
 Sorghum, II, 23, 44, 54, VII, 146, 159, VIII, 27
 Soulard Apple, V, 87

- Sour Cherry, VII, 159
 Southern Fox Grape, III, 77, IV, 60, 62, 63, VI, 48, 72, 75
 Spanish Chestnut, IV, 56
speciosum, *Ribes*, IX, 2
 Spice-bush, IV, 123
 Spinach, II, 113
Spiraea, V, 154
 ulmaria, III, 51
 Spruce, III, 112
 Norway, I, 150, VII, 172, VIII, 119, IX, 80
 Squash, II, 64, 66, 70
 Staghorn Sumach, VI, 119
 Standard Pear, I, 128
 St. Augustine Grape, V, 63
Stellaria media, I, 179
 Stickseed, V, 52
 Stink-weed, VI, 121
Stipa setigera, VII, 192
 St. John's Wort, II, 10
stramonium, *Datura*, V, 56
 Strawberry, I, 142, 143, 157, II, 34, III, 11, 42, 43, 82, 83, 105, IV, 34, V, 114, VII, 46, 47, 48, 159, IX, 27
strictum, *Echinosperrum*, V, 52
 String bean, III, 105
strobilus, *Pinus*, I, 24
Strombocarpa monoica, I, 65
strumarium, *Xanthium*, I, 92
 Sugar Grape, IV, 61
 Sumach, I, 100, II, 58, III, 130, VI, 118, 127, VII, 160
 Dwarf, VI, 119
 Fragrant, VI, 121, IX, 6
 Smooth, VI, 119
 Staghorn, VI, 119
 Venetian, VI, 119
 Summer Grape, III, 89, 90, IV, 60, 63, VI, 47, 72
 Rose Apple, V, 86
 Sunflower, III, 68, 131, IV, 142, V, 52, Supp., 53
 Swamp Rose-mallow, VI, 92
 Sweet Cherry, VII, 159
 Gum, IV, 123, 124, 140
 June Apple, V, 75
 -potato, I, 100, II, 56, 57, 58, 60, 61, 62, 63, VII, 146
 Bermuda, II, 61
 Brazilian, II, 61
 Nansemond, II, 61
 Sycamore, I, 150, III, 114, 127, IV, 126, 129, VI, 128, IX, 127
sylvestris, *Malva*, VI, 89
 Pinus, I, 24, V, 100
Symphoricarpos racemosus, II, 113
 vulgaris, I, 153
- T.**
- Tallman's Sweet Apple, III, 35
 Taylor Grape, I, 30, III, 87, IV, 63, 64, V, 63, 65, 66, VI, 36, 47, 48, 68, 80, 95, VII, 102, 115
 Bullet Grape, VI, 73
 Teasel, IV, 112
 Telegraph Grape, V, 65, VI, 47, VII, 106
 Thistle, I, 180, II, 10, 112, III, 67
 Canada, II, 10
 Thorn, III, 120, IV, 126
 -apple, IV, 10
 Thoroughwort, VI, 12
Thuja occidentalis, I, 24
thunbergii, *Vitis*, VI, 71
Tilia, IV, 126
 Timothy, III, 111, VII, 38, 146, VIII, 39, 49, 50, 143, IX, 51
 Tinto Grape, VI, 86
 Toad-flax, II, 10
 Tobacco, I, 80, 96, 105, IV, 10, VII, 146, 159
 Tokay Grape, V, 66
 Tomato, I, 80, 92, 95, 107, 108, III, 105, IV, 10, VI, 12, VII, 146
tomentosa, *Aristolochia*, II, 116
 Oratagus, III, 36
 Tonzuru, IV, 136
Torrubia cinerea, VI, 123
 militaris, VI, 123
toxicodendron, *Rhus*, V, 127, VI, 121
 Transcendent Crab, I, 15
 Trees, growth of trunk of, VI, 96
trichostemmoides, *Salvia*, VIII, 119
trifida, *Ambrosia*, Supp., 56
Triosteum perfoliatum, III, 134
 Trumpet Creeper, III, 64, VI, 87
tuberosa, *Asclepias*, III, 144
tuberosum, *Solanum*, II, 56, VIII, 9
tuberosus, *Helianthus*, VIII, 143
tuckeri, *Oidium*, V, 57, 70, VI, 30, 63, 79, 85, IX, 43
tulipifera, *Liriodendron*, Supp., 55
 Tulip tree, IV, 123, Supp., 55
 Turnip, I, 101, II, 105, 114, III, 111, 109, 111, 141, IV, 36, V, 69, 111, 114, VII, 159, VIII, 143
typhina, *Rhus*, VI, 119
- U.**
- ulmaria*, *Spiraea*, III, 51
Ulmus, VI, 137
Urticaceae, IV, 100
- V.**
- vaginæflora*, *Vilfa*, VIII, 122
 Venango Grape, VI, 84
 Venetian Sumach, VI, 119
Verbascum, V, 35, VII, 14
 Verbena, III, 68
verna, *Potentilla*, I, 143
Vernonia, V, 136
 fasciculata, I, 153
 novæboracensis, VIII, 119
Veronica peregrina, II, 35, VII, 48
Vilfa, VIII, 123
Vilfa vaginæflora, VIII, 122
vinifera, *Vitis*, IV, 55, 63, V, 65, VI, 32, 47, 48, 72, 74, 78, 80, 85
 Virginia Creeper, II, 78, 86, III, 77, VI, 88
virginiana, *Juniperus*, I, 24
 Virginia Seedling Grape, IV, 61, VI, 74
Vitis aestivalis, III, 89, 90, IV, 60, 61, 63, VI, 36, 47, 48, 72, 74, 75, 80, VII, 103
 arizonica, IV, 60, VI, 73, 76
 californica, IV, 60, VI, 73
 candicans, IV, 60, VI, 73, 76
 cordifolia, III, 87, 88, 89, 90, IV, 60, V, 66, 118, VI, 36, 73, 74, 75, 76, VII, 96
 labrusca, III, 87, 89, 90, IV, 60, 63, V, 60, 65, 66, 118, VI, 36, 47, 48, 71, 72, 74, 75, 76, VII, 103
 linceumii, VI, 74
 monticola, VI, 57, 74
 mustangensis, IV, 62, VI, 76

Vitis riparia, IV, 60, 61, 63, V, 62, 65, 116, 118, VI, 36,
47, 48, 58, 72, 73, 74, 75, 95, VII, 96
rupestris, IV, 60, VI, 73, 74
thunbergii, VI, 71
vinifera, IV, 55, 63, V, 65, VI, 32, 47, 48, 72, 74,
78, 80, 85
vulpina, III, 77, 90, IV, 60, 63, V, 66, 118, VI, 48,
49, 72, 75, VII, 106
vulgaris, *Symphoricarpos*, I, 153
vulpina, *Vitis*, III, 77, 90, IV, 60, 63, V, 66, 118, VI,
48, 49, 72, 75, VII, 106

W.

Walter Grape, V, 59, 62, VI, 80
Walnut, I, 153, III, 125, 126, 127, IV, 42, 124, 126
Black, I, 153, III, 131, IV, 82, VII, 160,
Supp., 54
Warren Grape, VII, 102
warcewiczii, *Solanum*, IV, 10
Watermelon, III, 141
Water-weed, II, 11, IX, 43
Weehawken Grape, V, 59
Weeping Willow, II, 109
Wheat, I, 79, 87, 88, 159, 160, II, 16, 17, 23, 23, 30, 42,
44, 54, 55, III, 110, 111, 112, 115, 116, VII, 25, 27, 34,
38, 146, 168, 173, VIII, 25, 27, 49, 59, 143, IX, 51, 52,
Supp., 56
whipplei, *Yucca*, V, 157
White-berry, II, 113
Doyenne Pear, I, 15
Elm, I, 123
Grub fungus, I, 158, VI, 123, 125
Hellebore, IX, 13
Mulberry, I, 72, 73
Oak, III, 120, 127, VI, 64, 115
Pine, III, 92, V, 97, 100, 102, IX, 13, 29, 30, 32
Riesling Grape, VII, 102
Scotch Cluster Grape, VI, 77
Thorn, IV, 132, V, 86
Willow, IV, 72, V, 120
-wood, II, 91
Whortleberry, III, 163, Supp., 83
12 MO

Wild Black Currant, IX, 2
Cherry, IV, 123
Crab, IV, 42, Supp., 80
Endive, I, 79, 83
Plum, I, 15, 55
Rose, V, 126
Wilder Grape, IV, 63, V, 62, 63, VI, 48, 81, VII, 101,
102, 111, 116
Windsor Bean, I, 98, III, 51
Winesap Apple, IV, 45
Winter Grape, IV, 60, VI, 73
Willow, I, 24, III, 120, 153, 154, 163, 168, IV, 104, 112,
124, 126, 142, V, 127, 136, VI, 162, VII, 160
Golden, III, 168
Heart-shaped, IX, 20
Scrub, II, 90, III, 168, V, 132
Twig Apple, V, 87
Weeping, II, 109
White, IV, 72, V, 120
Witch Hazel, III, 120
Wormwood, V, 35

X.

Xanthium, VII, 159
strumarium, I, 92, III, 60

Y.

Yellow Bellflower Apple, IV, 45
Yellow Pine, V, 100
York Madeira Grape, IV, 64, V, 64
Yucca, V, 153, 159, 160, VI, 132, 133, 135, VIII, 169,
IX, 129
Yucca aloifolia, V, 153, VIII, 171, 178, IX, 129
angustifolia, V, 157, 159, VIII, 169
filamentosa, V, 158, 159, VIII, 171
flaccida, V, 159
glauca, V, 153
gloriosa, V, 159, 171
puberula, V, 153
rupicola, V, 157
whipplei, V, 157

ERRATA.

Page III, line 9, for **CLASSIFED** read **CLASSIFIED**.

Page 60, line 17, for **LEUCANÆÆ** read **LEUCANIÆ**.

Pages 93, 94. In making up these pages several of the names got misplaced. "Orgyia" and "Thyridopteryx," on p. 94 should follow "Epantheria" on p. 93. "Hæmatopis," on p. 94, should follow "Eufitchia," on p. 93. "Pronuba" and "Galleria," p. 94, should follow "Carpocapsa," on the same page; "Cæstrus" should follow "Pipiza" on the same page.

Page 94. After line 10 add "*Gelechia gallæsolidaginis*, larva and pupa: I, 173-174."



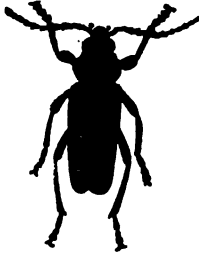
DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 7.

INSECTS

INJURIOUS TO

FOREST AND SHADE TREES.



By A. S. PACKARD, Jr., M. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1881.

MEMBERS OF THE COMMISSION.

CHARLES V. RILEY, *Chief*,
Washington, D. C.

A. S. PACKARD, JR., *Secretary*,
Providence, R. I.

CYRUS THOMAS, *Disbursing Agent*,
Carbondale, Ill.

INSECTS INJURIOUS TO FOREST AND SHADE TREES.

INTRODUCTION.

The design of this bulletin is to give to the public, especially those persons interested in forestry and the planting and cultivation of shade trees, a brief summary of what is up to this time known of the habits and appearance of such insects as are injurious to the more useful kinds of trees. It is hoped that such a compendium will be found useful, and lead the reader not only to refer to the works of Harris, Fitch, Walsh, Riley, Le Conte, Horn, LeBaron, Saunders, and others of our entomologists who have contributed to this neglected branch, but induce him to make careful observations on the habits of destructive forest insects and to carry on experiments as to the best remedies against their insidious attacks. The writer has added some notes of occasional observations made during the past twenty years in the forests of Maine and the woods of Massachusetts, as well as in Colorado, Utah, Montana, and on the Pacific coast, with a few original engravings; but the aim has been not so much to present original matter as to bring together from numerous entomological works, reports and journals and to present in a summary way, all that is of most importance to the practical man. It will be seen that really our knowledge of the subject is very scanty, and that the pamphlet is largely a simple list of the insects which live upon our more important forest trees. But the work may serve as a convenient synopsis, a starting-point, or handy book of reference for the use of future observers, and it is hoped that it will call the attention of the public to a neglected subject and stimulate entomologists and practical foresters and gardeners to do what they can to add to our knowledge of this department of applied or economic entomology.

The preservation of our forests and of old and valued shade trees in our cities and towns is a subject of pressing importance, and it is to be hoped that the government will foster private work and research in this direction. Next to the wanton destruction of forests by unthinking settlers and shiftless farmers, as well as fires caused by the sparks of locomotives, the attacks of injurious insects are most widespread and far reaching. Our forest and shade trees are yearly growing more valuable and indispensable, and at the same time the ravages of insects are becoming more widespread and noticeable. The diffusion of

a moderate amount of information upon the subject at the present time will attract the notice of the public and lead owners of land to pay a little attention to the subject and do something towards checking the ravages of noxious insects.

In France and Germany private persons, entomologists such as Perris in France, and especially Ratzeburg in Germany, have published beautifully illustrated general works of very great interest and value upon forest insects, and their works have done immense service in those countries, where an enlightened government and an intelligent people have felt the importance of building up schools of forestry and of making laws compelling due efforts towards repressing the more injurious forest insects.

Kaltenbach, in his work entitled "*Die Pflanzenfeinde aus der Klasse der Insekten*," or the Insect-enemies of Plants, has enumerated, in a closely-printed volume of 848 pages, the species of insects preying upon the different trees and plants of all sorts of Central Europe. The number of insects found upon some kinds of forest trees is astonishing, though it is to be remembered that all kinds are not equally destructive, the most injurious and deadly forms being comparatively few.

Kaltenbach enumerates 537 species of insects injurious to the oak, and 107 obnoxious to the elm. The poplars afford a livelihood to 264 kinds of insects; the willows yield food to 396 species; the birches harbor 270 species; the alder, 119; the beech, 154; the hazelnut, 97, and the hornbeam, 88. Coming to the coniferous trees, as the pine, spruce, larch, firs, etc., the junipers supply 33 species, while upon the pines, larch, spruce, and firs, collectively, prey 299 species of insects. In France Perris has observed over one hundred species either injurious to, or living upon without being especially injurious to, the maritime pine. These are described in an octavo volume of 532 pages, with numerous plates.

The number as yet known to attack the different kinds of trees in the United States may be seen by reference to the following pages. It is sufficiently large to excite great fears for the future prosperity of our diminished forests, unless the government interposes, and through the proper channels fosters entomological research in this direction. Our forests, moreover, are much richer in species of trees than those of Europe. We have, without doubt, on the trees corresponding to those of Europe as many destructive species as in Europe. But we have many more shade and forest trees of importance in the Eastern United States alone, and when we add to these the forest trees of the Western Rocky Mountain plateau and of the Pacific coast, and when we look forward to the attention which must be given in the immediate future to the planting of shade and forest trees on the great plains and in California, the subject of forest entomology assumes still more importance.

The author has here arranged the forest trees in the order of their importance, beginning with the hard-wood or deciduous trees, the oak

heading the list, and ending with the coniferous trees; and under each tree he has first described the habits of the insect on the whole most injurious, often merely giving a list of those insects found to be regular parasites of the tree but not specially injurious; but it should be borne in mind that any species of insect may at certain seasons so abound as to prove destructive.

This bulletin will be sent to entomologists and others who are interested in insects preying upon our shade and forest trees, or who are engaged in rearing coleopterous or lepidopterous larvæ, with the hope that they will aid the author by the communication of notes and specimens; or send the results of their discoveries for publication to some entomological journal. Insects in the larva and pupa stages may be put into alcohol, while the adult beetle or moth may be pinned, or enclosed in a tin box and the latter sent by mail; alcoholic specimens accompanied with the wood or bark or fruit infested, could be sent by express. Specimens showing the mines or burrows, or pressed and dried leaves containing the mines of leaf-borers, or twigs injured by twig borers, would be welcome. For purposes of full description and illustration coleopterous larvæ, as well as caterpillars, should be placed at first in weak alcohol, and after forty-eight hours transferred to alcohol of full strength. It is the writer's hope that the government may be ultimately induced to order the publication of an extended report, with the necessary illustration, upon forest insects, and any aid rendered in the preparation of such a volume would be appreciated and fully acknowledged. The author will be thankful for the correction of errors or omissions in this work. For valuable information regarding the food-trees of a number of beetles hitherto unpublished he is indebted to Mr. George Hunt, of Providence, R. I., and for aid in collecting specimens he would acknowledge the assistance received from Mr. Edwin C. Calder, assistant instructor in chemistry, Brown University, and Mr. H. C. Bumpus, a member of the sophomore class of Brown University.

INSECTS INJURIOUS TO THE OAK.

(Various species of *Quercus*.)

AFFECTING THE ROOTS.

The roots of various species of oak are, without much doubt, more or less injured by the attacks of the seventeen-year Cicada while in its preparatory state; as it is known that this insect, so abundant in the central and southern States of the Union, remains for over sixteen years attached by its beak to the rootlets of the oak and probably other forest trees, where it sucks the sap, thus in a greater or less degree injuring the health of the tree. Observations as to the subterranean life of the seventeen-year locust are few and obscure, and it is quite uncertain how much injury is really done to trees by this habit. They have sometimes been found sucking the sap of forest trees, notably the oak,

and also of fruit trees, such as the pear and apple. According to Riley (First Report, p. 24), the larvæ are frequently found at great depth, sometimes as much as ten feet below the surface. It has been claimed by Miss Margaretta H. Morris, in an account published in 1846, that pear trees have been killed by the larvæ sucking the roots. This has been denied by the late Dr. Smith of Baltimore, who says:

The larva obtains its food from the small vegetable radicals that everywhere pervade the fertile earth. It takes its food from the surface of these roots, consisting of the moist exudation (like animal perspiration), for which purpose its rostrum or snout is provided with three exceedingly delicate capillaries or hairs, which project from the tube of the snout and sweep over the surface, gathering up the minute drops of moisture. This is its only food. The mode of taking it can be seen by a good glass.—*Prairie Farmer*, December, 1851.

Mr. Riley adds that Dr. Hall, of Alton, Ill., has often found them firmly attached to different roots by the legs, but never found the beaks inserted. He remarks as follows:

The fact that they will rise from land which has been cleaned of timber, cultivated, and even built upon for over a dozen years, certainly contravenes Miss Morris's statement, while their long subterranean existence precludes the necessity of rapid suction. It is also quite certain that if they thus killed trees we should oftener hear of it, and I have captured a gigantic but unnamed species of Cicada on the plains of Colorado, 50 miles from any tree other than a few scattering willows.

We would add that in June, in Idaho Territory, we have seen numerous Cicadæ which had just appeared above the surface of the earth in a desert region with scattered sage bushes, upon whose roots, which it is known descend to a great depth, the young may feed. While, then, the Cicada may seldom do marked injury to the oak, the reader is referred to page 35 for a further notice of the injury done by this insect to the twigs and smaller branches of the oak and other trees.

In Europe the roots of oaks are affected by a small wingless gall-fly, which punctures the root and inserts an egg into the hole. The irritation thus set up causes the root to swell until a tumor or gall is formed, in the center of which lies the white footless larva or maggot of the fly.

Fitch has found similar wingless flies in this country, but they will always remain objects rather of a scientific than economic interest. He has described them under the names of *Biorhiza nigra*, *Cynips (Philonix) fulvicollis* and *nigricollis*. They are wingless, and occur in forests in November and December, often walking on the snow in company with other snow insects, such as *Boreus* and *Chionea*.

AFFECTING THE TRUNK.

1. THE LOCUST CARPENTER MOTH.

Xyleutes robinæ Harris.

Order LEPIDOPTERA; Family BOMBYCIDÆ.

Boring large holes and galleries in the trunk; a large livid reddish caterpillar, nearly three inches long, greenish beneath, and the head shining black; the body somewhat flattened, and with scattered long fine hairs. The chrysalis also in the burrow, and transforming to a large thick-bodied moth in June and July.

In different parts of New England, from Maine to Rhode Island, and

southward to Texas, oak lumber and cord wood is commonly seen to be often honeycombed by the large black burrows of this common and destructive borer. It is the most directly injurious of all the insects preying on this noble tree, since it sinks its tunnels deep in towards the heart of the tree in the living wood, and is a difficult insect to discover until after the injury is done. It may be found in the autumn and winter months, of different sizes, showing that at least there is an interval of one year between the smaller and larger sizes, and that consequently the moth is two years in attaining maturity.

The female moth, without doubt, lays her eggs in the cracks and interstices of the bark of the oak or locust, in the latitude of Boston, about the middle of July.

I have taken the larvæ and chrysalis from the red oak in Maine, and the insect occurs westward to the Mississippi Valley and southward to Bosque County, Central Texas. At Houston, Texas, I have found a dozen or more of the cast chrysalid skins projecting from a stump of the pin oak; one pupa was alive early in April. It is said by Fitch to be more common in the southern and southwestern States than in the northern. It is also an inhabitant of California, and may be found to occur in nearly all the United States wherever the black, red, and white oak or locust trees grow. The habits and metamorphoses of the moth were first discovered by Peck,* who bred it from caterpillars found in the locust, but Harris afterwards discovered that it "perforates the trunks of the red oak."

The following account of its habits and transformations is copied from Fitch:

Of all the wood-boring insects in our land this is by far the most pernicious, wounding the trees the most cruelly. The stateliest oaks in our forests are ruined, probably in every instance where one of these borers obtains a lodgment in their trunks. It perforates a hole the size of a half-inch auger, or large enough to admit the little finger, and requiring three or four years for the bark to close together over it. This hole running inward to the heart of the tree, and admitting the water thereto from every shower that passes, causes a decay in the wood to commence, and the tree never regains its previous soundness.†

This is also a most prolific insect. The abdomen of the female is so filled and distended with eggs that it becomes unwieldy and inert, falling from side to side as its position is shifted. A specimen which I once obtained, extruded upwards of three hundred eggs within a few hours after its capture, its abdomen becoming diminished hereby to nearly half its previous bulk; and in the analogous European species more than a thousand eggs have been found on dissection. It hence appears that a single one of these insects is capable of ruining a whole forest of oak trees. This calamity, however, is prevented, probably by most of the eggs being destroyed, either by birds or by other insects, for these borers are by no means so common in our trees as the fecundity of their parents would lead us to expect.

Our moth comes abroad, as already stated, in June and the forepart of July. It flies only in the night time, remaining at rest during the day, clinging to the trunks of

* Mass. Agr. Report and Journal, vol. v, p. 67, with a plate, 1818.

† We have observed that the old burrows are lined by a dark layer, consisting of a mealy debris about as thick as pasteboard; this detritus is probably composed of the castings of the larva, forming a paste which in drying strongly adheres to the sides of the gallery.—A. S. P.

trees, its gray color being so similar to that of the bark that it usually escapes notice. In repose its wings are held together in the shape of a roof, covering the hind body. From observing her motions in confinement, I think the female does not insert her eggs into the bark, but merely drops them into the cracks and crevices upon its outer surface. They are coated with a glutinous matter which immediately dries and hardens on exposure to the air, whereby they adhere to the spot where they touch; and if the short two-jointed ovipositor be not fully exerted as the egg is passed through it, so as to carry the egg beyond the hair-like scales with which the body is clothed, some of these touching adhere to it, their attachment to the body being so slight.

The eggs are of a broad oval form, and about half the size of a grain of wheat, being the tenth of an inch in length and three-fourths as thick, of a dirty whitish color with one of the ends black. When highly magnified their surface is seen to be reticulated or occupied by numerous slightly impressed dots arranged in rows like the meshes in a net. From the fact that several worms of the same size are sometimes met with in a single tree, indicating them all to be the progeny of one parent, it appears that the female drops a number of eggs upon each tree that she visits, and probably disposes of her whole supply upon a very few trees. The size of the eggs doubtless renders them a favorite article of food to some of our smaller birds. And a bird in discovering some of these eggs will be incited thereby to search for others in the same vicinity, which search being successful, will be perseveringly continued so long as an egg can be found upon that or any of the adjacent trees. Thus it may be that of the whole stock of eggs which a female deposits, scarcely one escapes being picked up and devoured. This appears the most probable cause of so few of these worms being met with, although the females are so prolific.

The worm on hatching from the egg sinks itself inward and feeds at first on the soft inner bark, till its jaws acquiring more strength it penetrates to the harder sap-wood and finally resorts to the solid heart-wood, residing mostly in and around the center of the trunk, boring the wood here usually in a longitudinal direction, and moving backwards and forth in its burrow, enlarging it by gnawing its walls as it increases in size, whereby the excavation comes to present nearly the same diameter through its whole length. In an oak in which I met with two worms fully grown and several others but half grown, the whole of the central part of the trunk had been extensively mined by preceding generations of this insect and was in a state of incipient decay; and I thus had an opportunity to notice the fact that none of the worms were lying in the decaying wood, all being outside of this, where the wood was still sound. Hence it is evident that it is living healthy trees which this insect prefers, and not those which are sickly and decaying, which latter are preferred by the European *Cossus*, some authors say, though perhaps their observations have not been exact upon this point, for in the instance here alluded to it would have been said on a first glance that these worms preferred decaying wood, since the diseased heart of the tree was everywhere traversed with their burrows, and the sound wood showed few of them; and thus no doubt in many other cases we mistake the cause for the effect, and on seeing semi-putrid wood filled with worm-holes we suppose the worms have preferred wood of this character, when in truth it is these holes which have caused the decay of the wood.

These worms are probably three years in obtaining their growth. They cast off their skin several times, and after the last of these moultings their color becomes different from what it has previously been.

The larva previous to the last change of its skin is of a rose-red or a pale cherry-red color, often with a faint yellowish stripe along the middle of its back, on all except the three anterior rings. It is of a cylindrical form, slightly broadest anteriorly and a little flattened beneath. It is divided by transverse constrictions resembling broad shallow grooves into twelve rings, which are twice as broad as long. On each of these rings are a few pimples of a deep purple color, regularly placed, each

giving out a pale-brown bristle. Four of these pimples are on the back, placed at the angles of an imaginary square or a trapezoid having its hind side the longest, the two hinder pimples being larger. Small white dots confluent into broken lines may also be perceived, forming a transverse square in which the two anterior pimples are inclosed, and other dots less regularly placed, surrounding the two hind pimples except upon their hind side. Above the breathing pores on each side is also a large pimple, which, upon the four rings bearing the pro-legs, has a white dot in its lower edge, which dot does not appear in the corresponding pimples of the other rings. A minute pimple is also seen forward of the upper end of each breathing pore, below which all the under side of the worm is greenish white. The breathing pores are oval and light yellow, with a rusty brown oval spot in their center and a dark purple ring around their outer edge. Below them the skin bulges out, forming a longitudinal ridge, or rather two parallel ridges divided by a deep intervening furrow. Upon the upper one of these ridges near the middle of each ring is a round cherry-red spot in which are two small pimples, and on the lower ridge is a single one, placed farther back, whilst four others, equally minute, may be seen farther down and around the anterior base of the pro-legs. The second and third rings are shorter, each with fourteen pimples of different sizes, the larger ones forming a single transverse row. The first ring or neck is polished and of a dark tawny brown color on its upper side, with a white line in its middle disappearing anteriorly in a black two-lobed cloud. The head is but half as broad as the body, and is of a shining black color, tinged more or less with chestnut brown in its middle, with scattered punctures from which arise fine hairs. The antennæ are chestnut brown, conical and three-jointed, the last joint minute, with a bristle beside it given out from the apex of the second joint. The palpi are similar, with two small processes from the summit of their second joint, the outer one of which ends in a minute fourth joint. Of the eight pairs of legs, the three anterior are conical and end in a single chestnut-colored claw. The others are short, thick, and retractile, with their soles surrounded by a blackish fringe-like ring composed of a multitude of minute hooks, the last pair, however, having these hooks only around the anterior and outer half of their soles. Placed in a glass or tin vessel, this worm is perfectly helpless, being unable to cling with these hooks to a hard smooth surface.

With the last change of its skin it loses its bright-red color, and is then white, tinged with green at the sutures, and with a pale-green stripe along the middle of its back, which disappears at the sutures. The pimples are of a pale tawny yellow color with black centers. The head is light tawny yellow varied in its middle with greenish white, its anterior edge blackish and the jaws deep black.

As the moth into which this worm changes possesses no jaws or other implements by which it is possible for it to perforate the wood, it is necessary for the worm to prepare a way for its future escape from the tree; and the provisions which it makes for this end are truly interesting, indicating that the worm has a clear perception of what its future condition and requirements will be, both in its pupa and its perfect state. This is the more surprising when we recur to the fact that since its infancy this creature has been lying deeply bedded in the interior of the tree, the only act of its life having been to crawl lazily around in its cell and gnaw the wood there when impelled by hunger. How does it now come to do anything different from what it has been doing for months and years before? But, having got its growth and the time drawing near to have it change into a pupa or chrysalis, we see it engaging in a new work. It now bores a passage from the upper end of its cell, outward through the wood and bark till only a thin scale of the brittle dead outer bark remains. It is usually at the bottom of one of the large cracks or furrows in the bark that this passage ends, whereby the hole inside is less liable to be discovered by birds. The worm then diligently lines the walls of this hole with silken threads interspersed with its chips and forming a rough surface resembling felt, as it withdraws itself backwards for a distance of about three inches, thus placing itself beyond the reach of any bird or other

enemy outside of the tree, should its retreat be discovered; and it here incloses itself in a cocoon which it spins of silk, of a long oval form, having the end towards the outer opening much thinner and its threads more loosely woven. In this cocoon it throws off its larva skin and then appears in its nymph or pupa form.

The pupa is an inch and three-quarters long and half an inch thick, of a dull chestnut color, the rings of its abdomen paler, and on the back near the anterior edge of each ring is a row of angular teeth, resembling those of a saw, of a dark brown color and all of them inclining backward, these rows of teeth extending downwards upon each side below the breathing pores or about two-thirds of the distance around the body. On the middle of each ring is also a much shorter row of little tubercular points. Finally, upon the under side of the last segment are about four stouter conical teeth, the tips of which are drawn out into sharp points which are curved forward, so that when this last segment, which is tapering and smaller than the others, is bent downwards, these curved points will catch and hold the body from moving forward.

The pupa lies perfectly dormant in its cocoon probably a fortnight or longer. It then awakes from its slumbers and begins to writhe and bend itself from side to side. By this motion the rows of little teeth upon the rings of its abdomen, which incline backward as above described, catch in the threads of the cocoon, first upon one side and then upon the other, and thus move the body forward, whereby its head presses upon the loosely woven end of the cocoon, more and more firmly, until it forces its way through it, and the pupa works itself forward out of its cocoon. And the same writhing motion being continued, the teeth now catch in the threads with which the sides of the hole are lined, and thus, though destitute of feet, the pupa moves itself along till it reaches and breaks through the thin scale of bark which hitherto has closed the mouth of its burrow, and pushes itself onward till about three-fourths of its length protrude from the tree, when by curving the tip of its body downward the four little hooks thereon catch in some of the threads and hold it from advancing further and falling to the ground. By so much motion of the pupa the connections of the inclosed insect with its shell become sundered and the sutures of the shell are probably cracked open, so that the moth readily presses them apart and crawls out therefrom, leaving the empty and now lifeless shell projecting out from the mouth of the hole, with a small mass of worm-dust surrounding it.

The male moth is of a gray color from white scales intermixed with black ones. The head is furnished upon the crown, or vertex, with longer or hair-like scales. The antennæ are tapering and many-jointed, their basal joint thickest and covered with black and gray scales, the remaining joints being naked, shining, coal-black, each joint bearing two branches on its front side, forming two rows of coarse teeth like those of a comb, the teeth being six or more times as long as thick, and all of the same length except at the base and tip, where they become shorter, all of them ciliated with fine hairs. The feelers are appressed to the face and reach as high as to the middle of the eyes, and are cylindric, clothed with short appressed scales, the separation of the terminal joint being slightly perceptible. The *thorax* has the shoulder-covers black, forming a stripe of this color along each side, which anteriorly curves downwards and is continued backward upon the upper side of the breast. Its base is clothed with larger scales, forming tufts upon each side. The *abdomen* is conic and equals the tips of the wings in its length, and is but slightly covered with scales except along each side, where they form a broad stripe, the under side being entirely denuded; it is black and shining, with the sutures dull yellowish. At its tip are three appendages, longer than the last rings of the abdomen. The two lower ones are broad, thick, flattened processes of a dull brownish yellow color, with their tips rounded and slightly bent inwards towards each other. The upper one is a slender, black, shining hook or claw of the same length, its tip sharp-pointed and curved downward. Above these appendages and hiding them from view is a brush of black hairs, forming a conical tuft at the end of the abdomen, blunt at its apex. The *legs* are more or less denuded of scales, black and shining, with the hind shanks thicker towards their tips

and with two pairs of spurs, the forward shanks having only a single spine, which is placed on the middle of their inner sides, the same as in other moths; and the feet are compressed, and five-jointed, with the basal joint longest and the following ones successively shorter. The *fore wings* are black, with groups of whitish scales forming gray spots or clouds which are netted with black lines, varying greatly in different individuals. Often a transverse gray spot is situated towards the base and another on the anal angle, the outer and hind margins being gray alternated with black. The *hind wings* are black, with their posterior half of a rich marigold yellow color bordered with a black line upon the hind margin, the yellow color being irregularly notched on its anterior side and narrowed to the inner angle, and not extended to the outer angle, the two outer cells being black. The outer or anterior margin, except at its base and tip, is usually gray alternated with transverse black streaks and blotches, and inside of this is a large ash-gray spot occupying the outer anterior part of the disk. The under sides of both wings is similar to their upper surface.

The *female* would not be supposed to pertain to the same species with the male, her size is so much larger, her colors so much paler gray, and her hind wings being wholly destitute of the bright yellow coloring which forms so conspicuous a mark in the other sex. The branches of her antennæ are also shorter, being but about four times as long as thick. The ground color of her *fore wings* is gray, variously netted with black lines dividing the gray in places into small roundish spots and into rings having black centers. The black color usually forms a broad irregular band across the middle of the wings parallel with the hind margin, and another between this and the hind edge, chiefly on the outer half of the wing, the hind edge and fringe being whitish alternated with black spots placed on the tips of the veins. The hind wings are dusky gray and towards their bases blackish, their posterior half being freely transparent and faintly netted with darker lines. The body is densely coated with gray scales, its under side hoary white; and the legs are gray, with black bands on the shanks, and black feet, with gray rings at their articulations.

REMEDIES.—We have but a single suggestion to make upon the subject of remedies against this truly formidable though fortunately rare enemy. It is probable that soft scap applied the fore part of June to the bodies of trees will be equally efficacious against this and other borers as it is against that of the apple tree. This remedy may well be resorted to, to protect the locusts and oaks which we value as ornamental trees; and scarce and valuable as timber is becoming in all the older settled sections of our country, I doubt not it will be found to be good economy to bestow similar attention upon the more valuable trees standing in our forests.

It should also be observed that whenever a hole made by a borer is discovered in the trunk of a tree, it should be immediately closed by inserting a plug therein, to exclude the wet which will otherwise be admitted hereby to the interior of the tree and produce a decay of the surrounding wood.

2. THE OAK COSSUS.

Xyleutes (Cossus) querciperda Fitch.

Order LEPIDOPTERA; Family BOMBYCIDÆ.

Another and rather smaller borer, but belonging to a closely allied species, was found by Mr. J. A. Lintner resting upon the trunk of an oak tree in Schoharie, N. Y. It probably ranges all over the Eastern States and Mississippi Valley, since a species, either this or closely allied, is reported to us by Mr. G. W. Belfrage to inhabit Central Texas. Dr. Fitch thinks it probable that it bores into the oak. He describes it as a moth smaller in size than *X. robinia*, with thin and slight transparent

wings which are crossed by numerous black lines, the outer margin only of the forward pair being opaque and of a gray color; the hind wings of the male are colorless, with the inner margin broadly blackish and the hind edge coal-black.

3. THE RED-OAK FLAT-HEADED BORER.

Chrysobothris dentipes Germar.

Order COLEOPTERA; Family BUPRESTIDÆ.

Eating a slender, winding, broad, shallow burrow between the bark and sap-wood of newly-felled oak trees; a white, footless grub, with the fore part of the body enormously large, circular, and flattened, inclosing the small head in front.

This singularly-shaped borer is often found under the bark of newly-felled oaks, or those which have been prostrate for a longer time. The one here roughly figured occurred with others under the bark of the red oak at Salem, Mass., early in May, in company with more numerous individuals of *Magdalis olyra*, a small weevil also common in the Northern States, under the loosened, partly decayed bark of the oak.

It will be seen by the form of this singular borer that it is adapted for a life under or next to the bark of diseased trees, as it is quite unfitted, by reason of the enormously swollen front rings of the body, for boring very far into the living fresh wood, as is the case with the oak-boring caterpillar of *Xyleutes robinia*, or the oak pruner (*Stenocorus putator*). With its short, powerful jaws it can eat its way on either side in front of it, after hatching from the egg which is probably laid by the parent beetle in some crack in the bark. Its head is rather small and partly sunken within the segment next behind the head. This segment, destined to be the prothorax of the beetle, is remarkably broad, nearly three times as much so as the hinder segments, and fully as broad again as it is long, while the surface above is flat and more or less rough or pitted in the middle. With this unusual form it can eat its way in a serpentine course under the bark, deriving its nourishment from the sap-wood next to the bark. Owing to the form of its body in front, the burrow

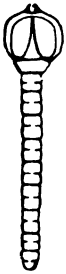


FIG. 1. Supposed larva of *C. dentipes*, enlarged. — From Packard.

is shallow and broad, in transverse outline oval cylindrical. The body of this as well as most other borers is provided with fine, delicate, scattered hairs, projecting on each side of each segment. Judging by analogy, these hairs are probably provided each with a fine nerve (though this remains to be proved), and probably are endowed with a delicate sense of touch, useful to the insect as it moves to and fro in its gallery. The Buprestid larvæ are blind, without simple eyes, since living as they do in total darkness and never coming to the light they do not need even the simple eyes present in many other larvæ, and which are probably chiefly of use in enabling the insect to distinguish light from darkness.

The larvæ of the *Buprestidæ* and the breeding habits of the beetles

have not as yet been carefully studied in America, and for any exact knowledge we have to go to French and German authors.

According to Perris, the Buprestids couple in the usual manner, the male mounting upon the back of the female, the act of copulation not being of long duration.

The form of the eggs and their size in our species are unknown, or have not been stated in print. It is most probable that the female lays them in the bottom of cracks in the bark, or under the partly loosened bark at least, where the larva upon hatching may find itself next to or immediately in contact with the bast or the sap-wood, which probably forms the greater part of its food, though Ratzeburg has found that the "frass" or excrement is colored by the bark, which indicates that the larvæ feed both on the bast and bark. As to the number of eggs laid by the female we have no information. The eggs are deposited in fissures or cracks by means of the extensile end of the body. As Westwood states, "The abdomen appears to be composed of only five segments. The remainder are, however, internal, and constitute in the female a retractile, corneous, conical plate, employed for depositing the eggs in the chinks of the bark of trees within which the larvæ feed." Perris, however, says that "the eggs are deposited in the interior of the bark, the outer layers of which the ovipositor of the female penetrates."

It has been claimed by Ratzeburg and also by Reifsig* that the European larvæ of Buprestis and the numerous allied genera, such as *Chrysobothris*, *Chalcophora*, &c., attain their full size in two years; but according to Perris the time required for transformation is but a single year, as may be seen by the extracts from his work further on.

As regards the habits of the larvæ we have no direct observation on the young of this family in this country, though much needed in connection with the use of remedial measures.

Mr. E. Perris, in his invaluable work, entitled "*Insectes du Pin maritime*," says of the larva of the European *Ancylocheira flavomaculata*:

The larva of the *A. flavomaculata* lives in the wood of old pines recently dead, and especially in the larger branches and the large twigs (*pieux*). It is, indeed, under these two last conditions that they oftenest occur. It does not stop in the bark, because it is in the interior of the bark that the female lays its eggs, by means of its oviduct, and after its birth it plunges into the wood to the depth of about a centimeter [nearly two-fifths of an inch]. It follows the longitudinal fibers of the sap-wood while making a gallery elliptical in section, which it leaves behind it completely filled and packed with excrement and detritus. When the time of its metamorphosis approaches it goes towards the surface of the sap-wood, perforates it to the bark, sometimes makes a small incision into the latter, stops up the gallery with a plug made entirely of small, compacted chips; then it retires backward a little into a cell scooped out in the wood, and this is where it transforms into a pupa.

The following extract from Perris refers to the habits of *Chrysobothris solieri*, which also lives on the maritime pine in France. The habits of

* Ratzeburg's *Die Waldverderbnisse*, &c., ii, p. 380.

our *C. dentipes* of the oak, and *C. femorata* of the oak and different fruit trees, and *C. harrisii* of the white pine are probably quite similar.

According to my observations the *Chrysobothris* only lays its eggs on the trunks of pines from five to fifteen centimeters in diameter at the base, and on the branches of old trees. I have never found it on an old trunk, and when a large prostrate pine is deprived of its branches it is on them that it lives, and not on the trunk. I have already said that the larva lives at first under the bark; it there busies itself, sometimes attacking very plainly the sap-wood, sometimes boring a sinuous gallery, which it leaves behind it filled with white chips and excrements of a brownish red; but at the approach of winter it burrows into the wood, where it gouges out a gallery elliptical in section, the dimensions of which increase as its body grows larger. When the moment of transformation has arrived it returns into its gallery, and undergoes its metamorphosis sometimes more than two centimeters from the surface, because I have found some pupæ and perfect insects at this depth.

Perris calls attention to the fact that though the Buprestid beetles stand quite high in the Coleopterous series, yet their larvæ have an organization inferior to that of all other Coleopterous larvæ known. Thus, they have neither feet nor eyes, and there are no other Coleopterous larvæ which, as in the Buprestids, have very rudimentary labial palpi, and which consist of less than two joints.

The burrows of the Buprestid larvæ may nearly always be distinguished, says Perris, by their tortuous course, and by the fact that the excrement and detritus, instead of being accumulated in the gallery without order, are there disposed in small layers forming concentric arcs, whose opening is turned away from the larva, and of a regularity not less remarkable than characteristic.

This symmetrical arrangement has as its primary cause the dimensions of the gallery, which are out of proportion with the abdomen of the larva. The latter, because of the size of the anterior portion of its body, is obliged to give to its gallery a size sufficient for the posterior part to execute freely movements of advance and retreat, which have as their natural result the disposition *en arc* of the rejected material behind. On the other hand, the larva, in consequence of the dimensions of its gallery, in order to have points of support is obliged to bend the posterior part of the body on itself. It is, indeed, ordinarily found in this attitude, which allows it to press against the walls, so as to push itself ahead; but in this condition the abdomen forms an arc which, propping itself from the convex side on the detritus, causes the concavity of the successive beds. * * *

We have seen that some Buprestid larvæ undergo their metamorphoses in the interior of the bark, others in the thickness of the wood. It is, moreover, in this that the wisdom of nature is revealed, for it is not capriciously and without motive that things happen as I have described. We know, indeed, that if those larvæ which do not attack the young trees, as those of *Ancylocheira 8-guttata*, of *Chysobothris solieri*, and of *Anthaxia morio* and of several species of *Agrius*, should live under the bark they would not be sufficiently protected, because the bark is not thick enough and would easily separate from the wood. When, however, on the contrary, they live under the hard and thick bark of old trees, as *Melanophila tarda*, *Chrysobothris affinis*, *Agrius biguttatus*, and 4-guttatus, and others, they do not hesitate to take refuge in the bark, because they are there well sheltered, and because they save the beetle from making a long and difficult journey in order to make its exit, * * *

What is the duration of the life of the larvæ of the Buprestidæ? Ratzeburg is

inclined to believe that it is two years. M. Levaillant, whose observations are reproduced by M. Lucas in his notice of *Chalcophora*, is also disposed to think that those of this insect pass two years in the wood. The reason which he gives, and which is drawn from the size of the larvæ found from December to August, does not seem to me conclusive, because the female of *Chalcophora* is capable of laying eggs during almost the entire year. As to M. Ratzeburg, he has not, apparently, made careful observations in this respect.

As to myself, numerous facts authorize me to say that, in general, these larvæ only live one year. For example, some pines, poplars, and willows which I have cut down in the spring time with the design of obtaining Buprestids, have afforded me often very numerous perfect insects in May and June of the year following.

Some logs of oak, cut in January, 1847, and which lay during a whole year in the open air, furnished me in June and July, 1848, more than three hundred *Chrysobothris affinis*. The trunks of some large, very rigorous pines, cut down at the beginning of one year, contained pupæ of *Ancylocheira* in the following May. Finally, as regards all the species that I have here described, and for a number of others, I have, from my own experience, the certainty that the larvæ live only one year.

I admit that, without doubt, among these larvæ there are some which, not placed in conditions sufficiently favorable to complete during this period all the phases of their existence, and which, from one cause or another, may be retarded some months, for a year, even. I moreover accept the more willingly this fact, because I have had good occasions for observing this in larvæ which I have raised in my cabinet; but this is the exception, and the rule is that a single year suffices, in our country, for the development of the larvæ of the Buprestidæ.

The Buprestids in the perfect state love the daylight and sunshine. Before storms, when the air is calm and heavy and the sun is hot, they have an extraordinary activity; and when the weather gradually becomes cloudy and the wind rises they disappear from our sight. We know but little as to the nature of their food. *Chalcophora mariana* devours the young shoots of pines, *Anthaxia morio* and *chevrierii* eat, the first the petals of buttercups, the second those of *Cissus alyssoides*. Other *Anthaxiæ*, also, as well as *Trachys*, frequent different flowers. *Aphanisticus emarginatus* occurs on rushes (*joucs*), and I have sometimes taken *Acmæodera taniata* on the flowers of carrots. All these facts lead me to think that the Buprestids are phytophagous; but it appears that certain species are, accidentally at least, carnivorous. This appears from a communication made by M. Léon Fairmaire to the Société Entomologique, in its session of January 10, 1849, relative to the subject of *Chrysobothris solieri*.

Regarding our oak borer (*C. dentipes*), Harris states that it completes its transformations and comes out of the trees between the end of May and the first of July. This applies to Maine and Massachusetts. In New York, according to Dr. Fitch, the beetles are "often found basking in the sunshine on the bark of the trees in June and July."

We have found the mines of a Buprestid borer under the bark of the hemlock, with exactly the arrangement in concentric arcs of the castings described on p. 14.

The beetle.—This insect is so named from the little tooth on the under side of the thick fore legs. It is oblong, oval, and flattened, of a bronzed brownish or purplish-black color above, copper-colored beneath, and roughlike shagreen, with numerous punctures; the thorax is not so wide as the hinder part of the body; its hinder margin is hollowed on both sides to receive the rounded base of each wing-cover, and there are two smooth elevated lines on the middle; on each wing-cover there are three irregular, smooth, elevated lines, which are divided and interrupted by large thickly-punctured impressed spots, two of which are oblique; the tips are rounded. Length from $\frac{1}{4}$ to $\frac{1}{6}$ of an inch. (Harris.)

4. THE APPLE FLAT-HEADED BORER.

Chrysobothris femorata Fabricius.

Order COLEOPTERA; Family BUPRESTIDÆ.

Boring under the bark and in the sap-wood of the white oak, and in the Gulf States, the pin oak; a pale-yellow flat-headed grub, closely resembling the preceding species

This pernicious borer of the apple tree, as stated both by Harris and Fitch, originally infested the white oak, but since the settlement of the country has abounded in the apple and sometimes in the peach, though it may still be found to injure the white oak.

Fig. 3 will fairly represent the "mine" or gallery made under the bark of a stump of the white oak, as it occurred at Providence, R. I. The worm soon after hatching made the mine as is seen on the right of the figure, where after a sinuous course it opens into a broad shallow cell, and then after pursuing an irregular direction dilates on the left into a broad shallow cell two-thirds of an inch wide, the oval black spot in the upper right corner representing the hole made by the larva for the exit of the beetle. In this hole the beetle was found. The large cell is for the repose of the pupa.

At Houston, Texas, I found the larva and pupa in abundance, April 2, 1881, under the bark of large pin oak stumps, and of dead trees. The burrows were like those represented in Fig. 3, being irregular winding shallow burrows, not nearly so definite in outline as those made by longicorn borers. The mine is about $\frac{1}{2}$ inch wide, and terminates in a broad irregular oval cell $1\frac{1}{2}$ inches long and $\frac{1}{4}$ to $\frac{3}{8}$ inch wide. In this cell the pupa spends the winter and early spring. One end of this cell lies toward the outer side of the bark, so that even if there is not a clearly defined oval opening as in Fig. 3, the beetle on emerging from the pupa state can with little difficulty extricate itself from its cell and make its way out of doors by pushing aside a thin barrier of bark. In the case of one mine in the pin oak there was a quite regular oval cell built up by the larva between the wood and the bark, the partition consisting of a composition of fine bark dust, thus forming a rude cocoon. The insect occurred at Providence in the larva, pupa, and beetle states May 20, though the larvæ were the most abundant.

Harris says of it from his observations in Eastern Massachusetts:

Its time of appearance is from the end of May to the middle of July, during which it may often be seen, in the middle of the day, resting upon or flying round the trunks of white-oak trees and recently-cut timber of the same kind of wood. I have repeatedly taken it upon and under the bark of peach trees also. The grubs or larvæ bore into the trunks of these trees.

The following extracts from Dr. Fitch's first report will further serve to characterize the habits and appearance of this formidable pest of our most valuable forest, shade, and fruit trees. It will appear that Dr. Fitch has been the first to discover an ichneumon parasite in the larva

of this beetle, no European Buprestid beetle being, so far as we know, infested by internal parasites:

Another insect, which has not heretofore been noticed in our country as a borer in the apple tree, pertains to the family *Buprestidae*, or the brilliant snapping beetles. Mr. P. Barry, of the Mount Hope nurseries, Rochester, has forwarded to us sections of the body of some young apple trees, which were sent to him from a correspondent in Hillsborough, in Southern Ohio, who states that in that vicinity the borer, which is contained in the specimens sent, is doing great damage to the apple trees, and that he has had peach trees also killed by this same worm. From an examination of these specimens, it appears that this insect is quite similar to the common apple-tree borer in its habits. The parent insect deposits its eggs on the bark, from which a worm hatches, which passes through the bark and during the first periods of its life consumes the soft sap-wood immediately under the bark. But when the worm approaches maturity and has become stronger and more robust, it gnaws into the more solid heart-wood, forming a flattish, and not a cylindrical hole such as is formed by most other borers, the burrow which it excavates being twice as broad as it is high, the height measuring the tenth of an inch or slightly over. It is the latter part of summer when these worms thus sink themselves into the solid heart-wood of the tree, their burrow extending upwards from the spot under the bark where they had previously dwelt. On laying open one of these burrows I find it is more

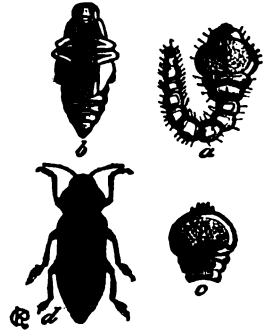


FIG. 2.—a, The apple flat-headed borer; b, pupa; c, under side of head and thoracic rings; d, beetle.—After Riley.



FIG. 3.—Mine or furrow made by the apple flat-headed borer, (*C. femorata*), nat. size.—Packard del.

than an inch in length, and all its lower part is filled and blocked up with the fine sawdust-like castings of the worm. Thus, when the worm is destined to lay torpid and inactive during the long months of winter, it has the forethought, so to speak, to place itself in a safe and secure retreat, within the solid wood of the tree, with the hole leading to its cell plugged up so as effectually to prevent any enemy from gaining admission to it.

Still, this worm is not able to secure itself entirely from those parasitic insects which are the destroyers of so many other species of its race, and which, as is currently remarked, appear to have been created for the express purpose of preying upon those species, in order to prevent their becoming excessively multiplied. We should expect that this and other borers, lying as they do beneath the bark or within the wood of trees, were so securely shielded that it would be im-

possible for any insect enemy to discover and gain access to them, to molest or destroy them. But among the specimens sent me by Mr. Barry is one where the worm has been entirely devoured, nothing but its shriveled skin remaining, within and upon which are several minute maggots or footless little grubs, soft, dull white, shining, of a long egg-shaped form, pointed at the tip and blunt in front, their bodies divided into

segments by very fine transverse impressed lines or sutures. They are about one-tenth of an inch long and 0.035 broad at the widest part. These are evidently the larvæ of some small Hymenopterous or bee-like insect, pertaining, there can be little doubt, to the family Chalcididæ, the female of which has the instinct to discover these borers, probably in the earlier periods of their life when they are lying directly beneath the bark, and piercing through the bark with her ovipositor, and puncturing the skin of the borer, drops her eggs therein, which subsequently hatch and subsist upon the borer, eventually destroying it. These minute larvæ were forwarded to me under the supposition that they were injurious to the apple tree, whereas, by destroying these pernicious borers, it is evident they must be regarded as our best friends. This fact illustrates how important it is for us to be acquainted with our insects in the different stages of their lives, that we may be able to discriminate friends from foes, and know which to destroy and which to cherish.

The larva.—The form of this borer is quite singular, and bears some resemblance to that of a tadpole or a battledoor. It consists of a very large, round, flattened portion, anteriorly, which is suddenly tapered into a long cylindrical tail or handle-like portion. The broad anterior part of this worm is about two-tenths of an inch in diameter and the narrow posterior part is but half as wide. Its length is about 0.65. It is soft, flesh-like, and of a pale-yellow color. In front two short robust jaws of a deep black color and highly polished are slightly protruded. When these are spread apart the tips of the feelers and between them the lips are perceptible. The head is blackish-brown and polished, and is deeply sunk into the second segment. Near each outer angle of the head is a small, pale-yellow, bead-like protuberance, which is probably the antenna. In Dr. Ratzeburg's figure, above alluded to, this slight protuberance is represented, probably incorrectly, as arising from the second segment. The second segment is deeply sunk into the third, and like all the remaining segments is pale-yellow and clothed with short minute hairs. The third or large segment is rather more broad than long, and is round and flattened above and beneath. Its upper side is occupied by a large, callous-like, transverse-oval elevation, the surface of which is flat and covered with numerous brown raised points, and in the middle are two smooth impressed lines, which diverge from the anterior to the posterior margin. Between these, on the middle of the basal edge, is a more faintly-impressed line, running forward, but becoming effaced before it reaches the center. On the under side is also a callous-like elevation, similar in all respects to that on the upper side, except that in place of the impressed lines it has in its middle a single channel or furrow, which does not extend to the posterior nor quite to the anterior margin. The fourth segment is a third narrower than the preceding, and has an impressed transverse line in its middle. In the deeply-impressed suture which divides this from the third segment, on each side is a smooth, crescent-shaped, elevated spot of a chestnut-brown color, resembling a little tick adhering in the fold of the skin. The nine remaining segments are of nearly equal length and diameter, except the two last, which are successively narrower. They are separated from each other by sutures which are strongly constricted. Along the middle of the back is a smoothish faintly-marked line, and on each side of each segment is an irregular triangular indentation, from the inner angle of which a faint impressed line extends inwards. On each side, beneath, is an impressed, longitudinal line. There are no conical projecting points at the apex of the last segment.

These borers, sent to me as above stated, have not yet completed their transformations; but they will in all probability remain in their present cells in the wood and be changed to pupæ the coming spring, from which the perfect insects will issue the latter part of May and during the month of June. And there can be little doubt that they will prove to be the species named by Fabricius *Buprestis femorata*, which species pertains to the modern genus *Chrysobothris*. This insect may be met with in all parts of our country. The natural place for its larva is in the white oak, and it is probable that, being deprived of a sufficient supply of this wood in which to deposit its eggs, in consequence of our forests being so rapidly and extensively cut down, this insect

has been obliged to resort to the apple and peach trees. Dr. Harris speaks of meeting with it upon and under the bark of peach trees, and I have captured it upon the apple tree. Professor Kirtland, of Cleveland, Ohio, doubtless alludes to this species (Downing's *Horticulturist*, vol. ii, p. 544), when he says, "Our apple trees are often injured by the larvæ of the *Buprestis*, which will girdle out extensive portions of the bark and young wood." This, moreover, is in all probability the beetle of which a wood-cut illustration is given in the *Ohio Cultivator*, vol. x, page 242. Although no description of the insect or its larvæ is given, the figure presents more points of resemblance to *C. femorata* than to any other common American species. The following interesting particulars there stated sufficiently indicate that this beetle will be liable to do great damage in our orchards. The editor says, "The late Dr. Barker, of McConnellsville (Morgan County, Ohio), called our attention to the injury done to his apple trees, by the beetle represented above, several years ago. It was in the month of July, and large numbers of these beetles were seen running up and down the trunks and branches of the trees, while beneath the bark extensive ravages of the larvæ were found. We observed, however, that these injuries seemed in nearly or quite all cases to have commenced where the bark had previously been killed from some other cause, and were almost invariably on the south side of the trees. We have since found occasional marks of these insects in other orchards, but never where the trees appeared to have been in perfect health previous to their attacks." This beetle, however, is by no means limited to old and decaying trees, as the observations of the editor of the *Ohio Cultivator* leads him to infer. The sections of wood sent me by Mr. Barry are from young and thrifty apple trees, and it occurs in oaks also of this character, as well as those which are aged and perishing.

The beetle.—Like other species of its family, the thick-legged *Buprestis* is variable in size, measuring from four to five-tenths of an inch in length, and about two-thirds in width. It is of a black or greenish-black color, polished and shining, with the surface rough and uneven. The head, and sometimes the thorax, and the depressed portions of the elytra are of a dull coppery color. The head is sunk into the thorax to the eyes, is densely punctured, and is clothed in front with fine white hairs, which are directed downwards. Upon the middle of the top of the head is a smooth raised black line, with a narrow impressed line through its middle, a mark which serves to distinguish this from some of the other species which are closely related to it. The thorax is much more broad than long, and is widest forward of the middle. Its surface is covered with dense, coarsish punctures, which run into each other in a somewhat transverse direction. It is also somewhat uneven, with slight elevations and hollows, but has not two smooth raised lines on its middle and anterior part, which are met with in another species very similar to this, the tooth-legged snapping-beetle (*Chrysobothris dentipes* Germar). The elytra or wing-covers present a much more rough and unequal surface than any other part of the insect. Three smooth and polished raised lines extend lengthwise of each wing-cover, and the intervals between them are in places occupied by smaller raised lines, which form a kind of net-work, and two impressed transverse spots may also be discerned more or less distinctly, dividing each wing-cover into three nearly equal portions. These spots reach from the inner one of the three raised lines nearly to the outer margin, crossing the two other raised lines, and interrupting them more or less. They are commonly of a cupreous tinge, and densely punctured, but are smoother than the other portions of the surface. A smaller and more deeply impressed spot may commonly be found in the space next to the suture and forward of the anterior spot, of which it is, as it were, a continuation. The wing-covers are rounded at their tips, so as to present a slight notch at the suture when they are closed, and the outer margin towards the tip has several very minute projecting teeth. When the wing-covers are parted the back is discovered to be of a brilliant bluish-green color, and thickly punctured, with a row of large impressed spots along the middle, one on each segment, and half way between these and the outer margin is another row of smaller impressed dots, having

their centers black. The under side of the body and the legs are brilliant coppery, the feet being deep shining green, their last joint and the hooks at its end black. Here also the surface is everywhere thickly punctured, the punctures on the venter or hind part of the body opening backwards. The last segment has an elevated line in the middle at its base, and its apex is out off by a straight line, in the middle of which is commonly a small projecting tooth. The anterior thighs are remarkably large, from which circumstance this species has received its name, and they have an angular projection on their inner sides, beyond the middle. The tibiae, or shanks, of these legs are slightly curved. (Fitch.)

Remedies.—We extract the following suggestions from Fitch:

The remedies for destroying this borer must necessarily be much the same with those already stated for the common borer or striped Saperda. They consist essentially of three measures: First, coating or impregnating the bark with some substance repulsive to the insect; second, destroying the beetle by hand-picking; and third, destroying the larva by cutting into and extracting it from its burrow.

As it is during the month of June and fore part of July that the beetle frequents the trees for the purpose of depositing its eggs in the bark, it is probable that white-washing the trunk and large limbs or rubbing them over with soft soap early in June will secure them from molestation from this enemy. And in districts where this borer is known to infest the apple trees the trees should be repeatedly inspected during this part of the year, and any of these beetles that are found upon them should be captured and destroyed. It is at midday of warm, sunshiny days that the search for them will be most successful, as they are then most active and show themselves abroad. The larvæ, when young, appear to have the same habit with most other borers, of keeping their burrow clean by throwing their castings out of it through a small orifice in the bark. They can, therefore, be discovered probably by the new sawdust-like powder which will be found adhering to the outer surface of the bark. In August or September, whilst the worms are yet young, and before they have penetrated the heart-wood, the trees should be carefully examined for these worms. Wherever, from any particles of the sawdust-like powder appearing externally upon the bark, one of these worms is suspected, it will be easy, at least in young trees, where the bark is thin and smooth, to ascertain by puncturing it with a stiff pin whether there is any hollow cavity beneath, and if one is discovered, the bark should be cut away with a knife until the worm is found and destroyed. After it has penetrated the solid wood it ceases to eject its castings, and, consequently, we are then left without any clew by which to discover it. Hence the importance of searching for it seasonably.

5. THE GREEN-HEADED BUPRESTIS.

Buprestis chlorocephala.

Order COLEOPTERA; family BUPRESTIDÆ.

Probably boring under the bark of the white oak, with habits similar to those of other flat-headed borers of the oak, a Buprestid beetle.

(Observed by Mr. George Hunt laying its eggs on the bark of the white oak at Providence, in June).

6. THE NORTHERN BRENTIAN.

Eupsalis minuta Drury.

Order COLEOPTERA; family BRENTHIDÆ.

Boring into the solid wood of the white oak, forming a cylindrical passage, a slender grub $\frac{1}{2}$ inch long and not quite 0.05 inch thick, changing to a weevil with a large, very thick snout.

The habits and transformations of this beetle were first described by Mr. Riley, the original account given by Dr. Harris proving erroneous,

his larva being that of a Tenebrionid beetle, as stated by Riley. This interesting weevil may be found on the trunk and under the bark of the white oak in June and July in New England, or in May and June in New York and Missouri, having then assumed the imago or beetle condition. Riley states that it is equally common on the black, red, and post oaks, that it bores in all directions through the heart-wood, and is found most commonly in stumps or in felled trees the year after they are cut.

The beetle differs from other weevils in that the snout projects straight out in front, not being curved downwards as in weevils in general. In the male the snout is much broader and flatter than in the female, but varies considerably, especially in the males, both in length and breadth. It is of a mahogany brown, the thorax smooth and highly polished, and the wing-covers strongly furrowed, shaded with deeper brown, and marked with narrow tawny-yellow spots. It is from $\frac{1}{4}$ to a little over $\frac{1}{2}$ an inch in length. The males are, contrary to the general rule in insects, almost invariably the larger. The males of the Brentnians are known to fight desperately for the female, and as has been remarked by Mr. A. R. Wallace,* it is interesting "as bearing on the question of sexual selection, that in this case, as in the stag beetles, when the males fight together, they should be not only better armed, but also much larger than the females." (Riley.)

According to Riley, in Missouri the eggs are deposited during the months of May and June. The female bores a cylindrical hole in the bark with her slender snout, and pushes an egg to the bottom of the hole.

It requires about a day to make a puncture and deposit the egg. During the time the puncture is being made the male stands guard, occasionally assisting the female in extracting her beak; this he does by stationing himself at a right angle with her body, and by pressing his heavy prosternum against the tip of her abdomen; her stout fore-legs serving as a fulcrum and her long body as a lever. When the beak is extracted, the female uses her antennæ for freeing the pincers or jaws of bits of wood or dust, the antennæ being furnished with stiff hairs and forming an excellent brush. Should a strange male approach, a heavy contest at once ensues, and continues until one or the other is thrown from the tree. The successful party then takes his station as guard. (W. R. Howard, in Riley's 6th Report.)

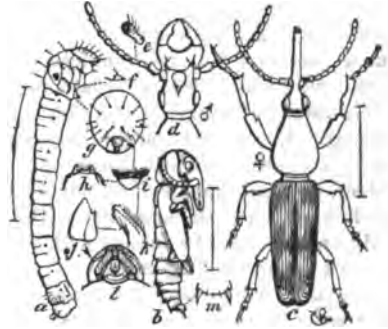


FIG. 4.—Northern Brentnians: *a*, larva; *b*, pupa; *c*, beetle, female; *d*, head of male; *e*, 4th antennal joint; *f*, leg; *g-i*, parts of larval head.—After Riley.

* The Malay Archipelago, p. 482.

† The line by the side of the insect in this and other cuts indicates the length of the insect, most of the sketches being enlarged views.

Riley thinks that the larva lives but a single year, although larvæ of different sizes occur in midwinter with the beetles.

The larva.—Length, 0.55–0.75 inch; diameter in middle of body, 0.05 inch. Body almost straight, cylindrical, 12-jointed, with a few faint hairs only on prothorax and around anus; thoracic joints short, bent a little forward, swollen and broadly and deeply wrinkled, with two especially prominent swellings on top of joints 2 and 3, converging towards head, and having each a granulated rufous spot; the other joints with about three dorsal transverse wrinkles; joints 5–9 subequal, as long as 1–3 together, twice as long as 4; 10–12 diminishing in length, slightly swollen, the anus retracted; 6 very small 3-jointed thoracic legs, the terminal joint being a mere bristle; stigmata quite distinct and brown, the first pair much the largest, between the fold of joints 2 and 3; the others on anterior fifth of joints 4–11, the last pair more dorsal than the rest. Head pale yellow, darker around mouth; rounded, more or less bent over the breast, with sparse, stiff, pale hairs springing from elevated points; ocelli, none; antennæ not visible, unless a dusky prominence lying close between mandibles and maxillæ be called such; labium small, with two depressions and other inequalities, the margins slightly angular, allowing jaws to closely fit around it; jaws stout, triangular, the inner margin produced at middle into a larger and smaller tooth, and with a slight excavation near tip; maxillæ long, with but a short, horny cardinal piece, the palpi apparently 2-jointed and with difficulty resolved, on account of three or four other prominences around them; garnished on the inside with a close row of stiff hairs and on the outside with two stouter hairs; labium large, oboval, the palpi placed in front and 2-jointed.

Pupa.—Average length 0.40 inch, with the antennæ curled back over the thorax, the seven or eight terminal joints each with a more or less distinct, forwardly-directed, brown thorn; the snout lying on the breast and varying according to sex; abdominal joints with a more or less distinct row of small thorns on the posterior dorsal edge, the last joint with a more prominent thorn directed backwards in a line with the body. (Riley.)

7. THE GRAY-SIDED OAK WEEVIL.

Pandeletius hiliaris Herbst.

Order COLEOPTERA; family CURCULIONIDÆ.

Making a smaller burrow than that of the Northern Brentian, a worm like that of the plum weevil and changing to a gray weevil found on the leaves from May to September.

Beyond the fact stated by Harris that the larva lives in the trunks of white oaks, on which the beetles occur from late in May to September, we know nothing of this insect.

The beetle.—A little pale-brown beetle, variegated with gray upon the sides. Its snout is short, broad, and slightly furrowed in the middle; there are three blackish stripes on the thorax, between which are two of a light-gray color; the wing-covers have a broad stripe of light gray on the outer side, edged within by a slender blackish line, and sending two short oblique branches almost across each wing-cover; and the fore legs are larger than the others. Length from $\frac{1}{4}$ to $\frac{1}{2}$ of an inch. (Harris.)

8. THE QUERCITRON BARK-BORER.

Graphisurus fasciatus De Geer.

Order COLEOPTERA; family CERAMBYCIDÆ.

Feeding upon and destroying the quercitron bark of newly-felled trees, forming large tracks filled with worm-dust, a white, footless grub about 0.60 inch long, and with a transverse oval tawny-yellow spot on the middle of each wing above and be-

low; in June transforming to a long-horned beetle about $\frac{1}{4}$ inch long, of an ash-gray color sprinkled with blackish spots and punctures, and back of the middle of its wing-covers an irregular oblique black band; the female with a straight awl-like ovipositor nearly $\frac{1}{4}$ inch in length. (Fitch.)

The bark called quercitron, of the *Quercus tinctoria*, is highly valued as a dye, and is much worm-eaten by this insect.

The parent of the worm differs remarkably from all the other beetles of this group in that the female is furnished with a straight awl-like ovipositor nearly a quarter of an inch in length, projecting horizontally backwards from the end of her body. The importance of this implement becomes manifest when we observe the thickness of the bark of the black oak, with its outer layers so dry and hard that they form, as it were, a coat of mail, protecting the trunk of the tree against the attacks of its enemies. Equipped as she is, however, the female of this beetle is able to perforate this hard outer bark and sink her eggs through it, placing them where her young will find themselves surrounded with their appropriate food. The worms from these eggs mine their burrows mostly lengthwise of the grain or fibers of the bark, and the channels which they excavate are so numerous and so filled with worm-dust of the same color with the bark, that it is difficult to trace them. The eggs are deposited the latter part of June, and the worms grow to their full size by the close of the season, and will be found during the winter and spring, lying in the inner layers of the bark, in a small oval flattened cavity about an inch in length, which is usually at the larger end of the track they have traveled.

The larva is divided by transverse constrictions into twelve rings, the last one being double. The head is small and retracted more or less into the neck, its base white and shining, and its anterior part deep tawny yellow, and along each side black. The neck or first ring is much longer as well as thicker than any of the others, the two rings next to it being shortest. From the neck the body of the worm is slightly tapered backwards to the middle, from whence it has nearly the same diameter to the tip, where it is bluntly rounded. Upon the upper side of the neck, occupying the basal half of this ring, is a large transverse tawny-yellow spot, rounded upon its forward side, but no corresponding spot appears on the under side of this ring. On the middle of all the other rings, except the two last, both above and below, is an elevated, rough, transverse, oval spot of a tawny-yellow color.

The beetle, like other species of the family to which it pertains, varies greatly in its size, specimens before me being of all lengths, from 0.35 to 0.58. It is of an ash-gray color from short incumbent hairs or scales, which have a faint tinge of tawny yellow except along the suture of the wing-covers. It is also bearded with fine erect blackish hairs which arise from coarsish black punctures which are sprinkled over the thorax and wing-covers, several of which punctures are in the centre of small black dots, which in places are confluent into small irregular spots. The head is of the same width as the anterior end of the thorax, and has a deep narrow furrow along its middle its whole length, and on the crown is an oval blackish spot on each side of this furrow. The face is dark gray, and the antennae are black with an ash-gray band occupying the basal half of each of the joints. The thorax is narrower than the wing-covers, more broad than long, and thickest across its middle. Upon each side slightly back of the middle is an angular projection or short broad spine, blunt at its tip. On the middle of the back, between the centre and the base, is a short impressed line, and on each side of this, extending the whole length of the thorax, is a wavy blackish stripe, which is suddenly widened towards its hind end, and is sometimes interrupted in its middle. Often, also, there is a blackish spot between the anterior ends of these stripes, extending from the centre of the thorax to its forward end. The scutellum is ash-gray in its middle and black upon each side. The wing-covers almost always show a large oblique and irregular triangular spot of black on their outer side forward of the middle, and always behind the middle is an irregular black oblique band, which seldom reaches to the suture, and which has a notch in the mid-

dle of its anterior side, and opposite to this on its hind side a large angular projection extending backward. Immediately back of this band is an irregular spot of a paler black color, which is sometimes confluent with the band; and there is also a small blackish spot on the outer side of the tips. The tips are cut off, sometimes transversely in a straight line, but usually concavely, and sometimes presenting a slight tooth-like projection on each side. The legs are ash-gray, the thighs with two black spots on their upper side, and the shanks with a black band at their base and another at their tip, these bands being more broad on the hind pair.

On elevating the loose bark of fallen trees the fore part of June, these insects will be found therein, lying in the cavities already mentioned, some of them being still in their pupa state, whilst others are changed to their perfect form, ready with the stout jaws and sharp teeth with which they are furnished to gnaw their way through the bark and come abroad.

This species occurs throughout the United States and Canada. Different specimens of it, however, vary greatly in their aspect. Even when newly born, among the individuals in the bark of the same tree, considerable diversities in size and markings may be noticed. And the beetles found in this situation have their colors so much brighter and their spots and bands so much more distinct and clearly defined, that I supposed them to be a different species from *fasciatus* for several years, and until specimens came to hand showing a gradual transition from these to the older individuals which we usually capture abroad, and meet with preserved in cabinets, in which the colors have become faded and dim and the marks obscure and partially obliterated. In the shape of some of its parts, also, different specimens are liable to vary. (Fitch.)

9. THE OAK LEIOPUS.

Leiopus querci (Fitch.)

Order COLEOPTERA; family CERAMBYCIDÆ.

A very small, long-horned beetle, which I am unable to refer to any of the described species, I am assured lives at the expense of the red and white oak, from meeting with it upon those trees standing apart from others in fields. As the larvæ of kindred species burrow in the bark of trees, this will probably be found in the same situation in oaks. The beetle is met with upon the leaves of these trees early in July. It is very closely related to the Facetious Leiopus.

It is 0.20 inch long, and black, with ash-gray wing-covers, which are punctured and marked with a large black spot on the base of their suture in the form of a cross, and a broad black band slightly back of their middle, which is angulated, somewhat resembling an inverted letter **W**, this band often having a small ash-gray spot placed in it near its outer ends. Forward of this band are two black dots or short lines on each wing-cover, and sometimes a third dot back of it. There is also a dusky spot, usually on the tips of the wing-covers, and their deflected outer margin is black. The wing-covers are rounded at their tips. The thorax sometimes shows three faint gray stripes above. It is narrowed anteriorly, and on each side slightly forward of the base is a short, broad, sharp-pointed spine, from the tip of which, forward, the sides are straight. The long, thread-like antennæ are dull yellow, with a slight duskiness at the end of each joint. The legs are blackish, with the bases of the thighs, and frequently of the shanks also, pale dull yellow, the hind thighs being less thickened towards their tips than the four forward ones. (Fitch.)

10. THE THUNDERBOLT BEETLE.

Arhopalus fulminans (Fabr.).

Order COLEOPTERA; family CERAMBYCIDÆ.

Excavating a burrow in the soft sap-wood, about three inches long and 0.20 inch in diameter, a worm like the apple-tree borer, which changes to a long-horned beetle.

This beetle is said by Fitch to infest the oak, excavating a burrow in

the soft sap-wood about three inches long and 0.20 inch in diameter, this burrow having the shape of a much bent bow or a letter **U**. It changes to a pupa in the same cell, the beetle appearing in July. We have also learned that it bores in the chestnut, and for a description and figure of the beetle would refer the reader to the account of insects infesting the chestnut.

11. THE WHITE OAK PHYMATODES.

Phymatodes variabilis (Fabr.).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring the trunk and branches of the white oak, a narrow longicorn larva, changing to a reddish thick-bodied longicorn beetle.

Numerous specimens of this beetle were taken by Mr. Alfred Poor from a white-oak stick, June 20. It is undoubtedly closely similar in its habits and in the form of the larva to the grape *Callidium* figured in our first report on the injurious insects of Massachusetts. This is the *Phymatodes variabilis*, and is one of our more common species of the genus. It is closely allied to *P. amœnus*, but is larger, and less coarsely punctured, while the antennæ are more reddish; the scutellum is concolorous with the wing-covers. The body, legs, except the femora, which are blackish in the middle, and antennæ, are reddish, the tips of the joints of the latter dark, and on the back of the prothorax are two black spots, often confluent. The head is black. The wing-covers are Prussian blue, smooth, finely punctured, with rather thick, fine, black hairs, bent downwards. Specimens recently changed from the pupa state are brown, and the species is exposed to considerable variation, as its name indicates. The male is just half an inch long, the female .60 inch.

The foregoing description is taken from our second report on the injurious insects of Massachusetts. We add the following description of the larva of a closely allied species, *P. amœnus*, Fig. 5, which injures the trunk of the grape.

The larva of the Grape Phymatodes.—Several years ago I received from Dr. Shimer, of Illinois, specimens of the larva, pupa, and adult of this pretty insect (*Callidium amœnum* of Say), which is not uncommon in our own State. So much alike are all the borers of this family of long-horned beetles, that long and prolix descriptions and carefully-drawn figures of the mouth parts (wherein most of the differences lie) are absolutely necessary for their identification.

The larva (Figs. 5, *a*; *b*, head seen from above; *c*, seen from beneath) has a small head, which is a little more than half as wide as the prothoracic segment. This latter, being the segment immediately succeeding the head, is half as long as broad, with a distinct median suture and four chitinous patches; the two middle ones transverse and irregularly oblong, being about twice as broad as long, the outer spots being longitudinal to the segment, and oblong in form, or about twice as long as broad. The three segments succeeding are of nearly equal length and width, being about half as long as the prothoracic segment, and not much narrower. The body decreases in width toward the posterior half, which is of equal width throughout, the end sud-

denly rounding off; the terminal three segments are indicated by very slightly marked sutures, and together form a straight cylindrical portion nearly as long as the three segments in advance of it taken collectively. The body is slightly hairy, with a few fine, pale hairs on the top of the segment next behind the head. The basal portion of the head (epicranium) is broad and smooth, with a few hairs on the edge. The eyes are two small black dots, each situated a little behind the base of the antennæ, and in a line with them. The frontal piece (clypeus) is very small, about three times as broad as long, while the minute upper lip (labrum) is two-thirds as long as broad; they together form a somewhat triangular portion resting on the inner edge of the

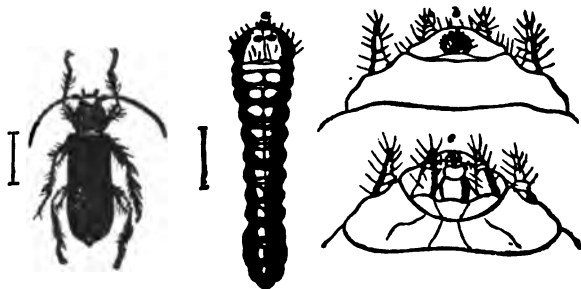


FIG. 5.—Grape Phymatodes: a, larva; b, upper side, c, under side of head of larva much enlarged.—From Packard.

mandibles, which are broad and short, the ends broad and square, and blackish in color. The antennæ are not quite so large or as long as the maxillary palpi; they are four-jointed; the first joint being thick, the second joint a third shorter than the third, while the fourth joint is filiform, and about as long as the second joint. The under side of the head is chitinous, with a mesial subtriangular fleshy area. The chin (mentum) is square, not much longer than broad. The under lip (labium) is one-half as long as broad. The labial palpi are three-jointed, the basal joint being one-half as long as the second; the third joint is minute, short and hairy. The maxillary palpi are four-jointed, the first joint being twice as thick as the third, the second and third are of nearly equal length, while the fourth is slender and nearly as long as the second or third. The maxillary lobe is large and broad, reaching out to the labial palpi and as far as the end of third joint of the maxillary palpi; there are a few hairs on the end of it.

On the upper side of the segments behind the prothoracic is a faint, transverse impressed line, with two or three short creases radiating from each end. On the eighth, ninth, and tenth rings these creases become much longer and are parallel to the median line of the body, while the transverse crease disappears.

There are nine pairs of stigmata, one pair on the mesothorax, the remainder on the first eight abdominal segments. There are three pairs of rudimentary thoracic feet, represented by very minute two-jointed tubercles, the basal joint consisting of a simple chitinous ring. The under side of the body is more hairy than above. On the under side of the prothoracic segment is a pair of round, smooth, very slightly chitinous spots, which are succeeded on each of the other rings by a pair of short, impressed oblique lines.

It is nearly half an inch (.45) in length.

It may be readily recognized by the four chitinous patches on the prothorax, and by the very minute clypeus and labrum. The upper side of the prothorax is inclined downward towards the head, but not so much as in *Clytus*.

The pupa.—It is white, with the wing-covers reaching to the end of the second abdominal segment. The antennæ are not much curved, reaching to the end of the third abdominal segment, and resting above the legs. The prothorax is swollen just behind the middle, and is just as long as broad. The maxillary palpi are long, reaching nearly to the end of the coxæ. The labial palpi reach a little beyond the middle of the maxillary palpi. The two anterior pairs of legs are folded at right angles to the body, the third pair obliquely. The first pair of tarsi reach to the base of the second tarsi; the second pair of tarsi reach to the coxæ of the third pair of legs. It is a third of an inch (.33) in length.

The beetle.—*Ph. amarus* has a reddish body, with Prussian-blue wing-covers. The prothorax is just as long as broad, with the sides moderately convex, and broadest just behind the middle. The antennæ and tibiæ are blackish brown, the tarsi being dull red, the hind pair being darker than the others, and the femora are reddish. The prothorax is distinctly punctured, while the elytra are very coarsely punctured. The scutellum is pale reddish. It is a quarter of an inch in length. A single specimen received from Illinois.

12. THE WHITE-BANDED PHYMATODES.

Phymatodes varius (Fabricius).

Order COLEOPTERA; family CERAMBYCIDÆ.

A black long-horned beetle, 0.25 in length, or slightly less, and about a third as broad, somewhat flattened, clothed with fine erect gray hairs; its wing-covers with two distinct slender white bands which do not reach the suture, the anterior one more slender than the hind one and curved; the antennæ and slender portions of the legs usually chestnut colored.

Several specimens of this beetle were met with a few years since, the last of May, on the trunk of a black oak, in which, it is probable, their younger state had been passed. It is closely related to the black varieties of *P. varius* Fab., but is a third smaller, with the white bands much more slender, and the surface of the wing-covers are perceptibly more rough than in my specimens of that insect, notwithstanding their smaller size. Its thorax is densely punctured, with a short smooth stripe between the center and the base. One of the specimens varies in having the posterior white band wholly wanting. (Fitch.)

I have found near Providence several of these beetles, of both sexes, running in and out of a pile of oak cord-wood in the forest, May 30, which was cut the previous winter.

13. THE COMMON OAK CLYTUS.

Clytus colonus.

Order COLEOPTERA; family CERAMBYCIDÆ.

Mining between the bark and the wood of the oak, up and down the trunk, and making a broad, shallow, irregular groove about 5^{mm} wide; the larva, pupa, and beetle occurring late in May and early in June.

I have found, in company with Mr. Calder, the larvæ of this pretty beetle in abundance mining under the bark of a fallen (probably white) oak, near Providence, May 26; several pupæ also occurred, one transforming to a beetle May 27. The mine extends up and down the trunk, and is of the usual form of longicorn mines, being a broad, shallow, irregularly sinuous burrow, and extending part of the way around the trunk, the diameter near the end of the burrow being 5^{mm}.

Mr. George Hunt has found the beetle under the bark of an old sugar maple tree in Northern New York, among the Adirondacks.

Larva.—Head broad; prothoracic segment large and broad, much wider than long, with two transverse chitinous portions in front, and one continuous band behind. Body behind rather stout and broad; no callous or fleshy bunches either above or below. Length, 13^{mm}; diameter of head across the thorax, 4½^{mm}.*

* This description, to be of much value, should be comparative, but I have at present no other larvæ of the genus with which to compare those of this species.

Pupa.—Prothorax well rounded as in Clytus beetles; antennæ slender, curving backwards, and reaching to the distal end of the middle femora. Femora much swollen, but the legs beyond slender, as in the beetle. (It will not be difficult to distinguish the genus from the peculiar form of the thorax, the swollen femora, and the slender legs and antennæ.) Abdomen short; end of hind femora extending to the third segment from the end of the abdomen. Length, 12-13½^{mm}.

14. SMODICUM CUCUJIFORME (Say).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in the larval stage under the dry bark of the live oak (Florida), the beech in Michigan, and the hackberry in Texas. (E. A. Schwarz.)

15. THE HORN-TAIL BORER.

Tremex columba (Linnaeus).

Order HYMENOPTERA; family UROCIDÆ.

This insect is known to infest the oak, but oftener bores into the maple, under which head the insect will be described.

16. MALLODON DASYSTOMUS (Say).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in live oak, hackberry, pecan; attacking trees in healthy condition, and often greatly injuring them, but preferring trees which have already suffered from some cause; the beetle issuing from April till August, in Florida and Texas. (E. A. Schwarz.)

17. MALLODON MELANOPUS (Linn.).

Boring in the box elder (*Acer negundo*) in Texas, and boring in the roots of oak shrubs at Cedar Keys, Fla., the beetle appearing in June; boring in *Celtis texana*, near Columbus, Texas. (E. A. Schwarz.)

18. THE OAK-BARK WEEVIL.

Magdalis olya (Herbst).

Order COLEOPTERA; family CURCULIONIDÆ.

Boring under the bark of the oak, probably after it has been loosened by the flat-headed borers, a curved fat footless grub, with the head freer from the body than in the larval pine weevil; occurring in all stages under the bark in May, and probably producing a radiating track, as in Fig. 7; transforming into a black weevil with the surface of the body punctured, the thorax with a lateral tubercle on the front edge, while the tarsi are brown, with whitish hairs; $\frac{1}{4}$ inch long. (Fig. 6).

Fig. 7 represents the mines probably made by this weevil. The original specimen of the bark was taken from the same tree, as numerous individuals of the beetle occurred in different stages of growth, and no other weevils or Scolytidæ were present. The beetle which makes the burrow must have been a weevil by the shape of the burrow, which is long, narrow, and deep, being about four inches long. It will be seen by reference to the illustration that the parent weevil laid at least seven eggs in an opening in the bark; when the larva hatched they mined

the bark and scored the wood in directions radiating on one side of the place of oviposition; in one case a mine went directly across the one next to it.

The following beetles are not known with certainty, but supposed by Harris and also by Fitch, from their frequent occurrence on the oak, to injure that tree:

19. THE SILKY TIMBER-BEETLE.

Lymexylon sericeum (Harris).

Order COLEOPTERA; family LYMEXYLONIDÆ.

Boring small long cylindrical burrows in the wood of the oak, probably, and other trees; a slender odd-looking worm with six legs placed on its breast, a prominent hump upon its neck, and a leaf-like fleshy appendage at the end of its back; changing into a long narrow chestnut-brown beetle, 0.50 long, bearded with short, shining, yellowish hairs, giving it a silky luster; its eyes large and almost meeting together above and below, and its wing-covers tapering and shorter than the body. See Harris' Treatise, p. 51. (Fitch.)

20. THE AMERICAN TIMBER-BEETLE.

Hylecæstus americanus (Harris).

Order COLEOPTERA; family LYMEXYLONIDÆ.

A worm very similar to the preceding, but with a straight sharp-pointed horn at the end of its

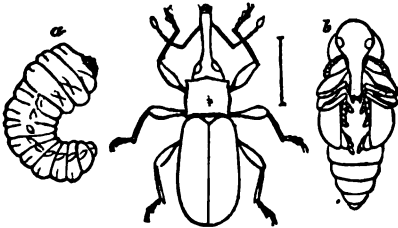


FIG. 6.—a, larva; b, pupa, and adult of the oak bark weevil, *M. olivæ* (from Packard).

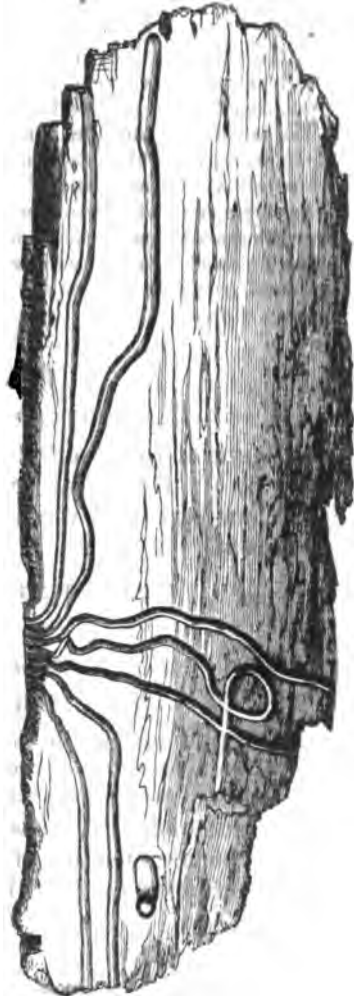


FIG. 7.—Track probably made by *Magdalis olivæ* (from Packard).

back in place of a leaf-like appendage; changing into a pale brownish red beetle 0.40 long; its wing covers, except at their base and its breast, black, its eyes small, and a glassy dot on the middle of its forehead resembling a small eyelet. (See Harris' Treatise, p. 51.)

This and the preceding are very rare insects, and their larvæ have never been detected, but are inferred by Dr. Harris to inhabit oaks and to have the singular forms above indicated, from the analogy of the perfect insects to two European species, Foreign writers, I see, are misled by Dr. Harris's account, into supposing that it is authentically ascertained that our insects coincide in their larva state with the European species. (Fitch.)

21. THE FEEBLE OAK-BORER.

Goes debilis (Leconte).

Order COLEOPTERA; family CERAMBYCIDÆ.

A cylindrical long-horned beetle, which has recently been described by Dr. Le Conte, under the above name, is so uniformly found upon white oak trees in July and August, that I doubt not its larva is a borer in the trunks of these trees, perforating the wood, probably, in a manner similar to that of the marked pine borer, and the worm resembling that in its appearance. This beetle is half an inch long and scarcely a third as broad, of a black color, its wing-covers chestnut red, its surface having a marbled appearance, produced by short prostrate hairs of a dull ochre yellow color, except on the anterior half of the wing-covers, where they are gray, and are here followed by a tawny brown spot destitute of these paler hairs. It has only been found, as yet, in the State of New York, in the northern sections of which it is not rare. (Fitch.)

22. THE BROWN PRIONUS.

Orthosoma brunneum.

Order COLEOPTERA; family CERAMBYCIDÆ.

The larvæ of this beetle has been found in rotten walnut and oak stumps by Mr. Hunt near Providence, but as it is more commonly met with in pine logs the reader is referred to the account of it given under pine insects.

AFFECTING THE LIMBS AND TWIGGS.

23. THE OAK PRUNER.

Elaphidion villosum (Fabr.).

Order COLEOPTERA; family CERAMBYCIDÆ.

Cutting off the branches of the white and black oak (each containing a larva, which fall late in summer to the ground), longicorn larvæ, which become beetles in the next midsummer, and lay their eggs near the axilla of a leaf stalk or small stem.

In walking under oak trees in the autumn one's attention is often directed to the large number of oak limbs and twigs lying on the ground. Upon examination they will be found to have been partially gnawn off

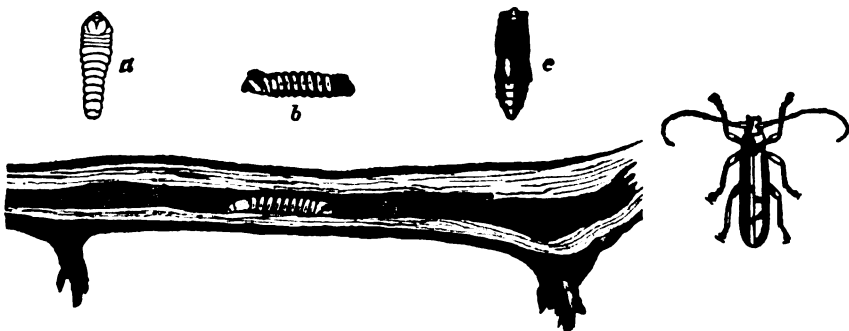


FIG. 8. Oak Pruner: a, larva; b, side view of the same; c, pupa.—From Packard.

by worms, the wind having further broken them off. This is the work of the grub of the oak pruner. The insect's purpose in cutting off the

limb, whether conscious or not of any design in the matter, is probably, as Peck first suggested, to afford the grub a sufficiently moist retreat to live in during the winter. He supposed that the limb thus wounded would become too dry for the maintenance of the soft-bodied larva, hence it must be felled to the ground, where in the wet and under the snows of winter it would remain sufficiently moist for the existence of the insect, which completes its transformation within.

Mr. C. A. Walker has brought us the insect in its different stages cut out of oak branches, which occurred in abundance at Chelsea, Mass., but, as seen by the following extracts, we are indebted to Dr. Fitch for the most detailed information regarding this curious longicorn.

The severed limbs are usually but eighteen inches or two feet in length, but Professor Peck states that limbs an inch in thickness and five feet in length are sometimes found. I have seen a limb cut off by this insect which was ten feet in length and an inch and a tenth in thickness, and have repeatedly met with them seven and eight feet long and usually an inch, but in one instance an inch and a quarter, in thickness.

The parent beetle seems aware that her progeny in their infancy will be too feeble to masticate the hard woody fibers of the limb. She, therefore, selects one of the small twigs which branch off from it, which is not thicker than a goose quill, with its base composed of soft wood, the growth of the last year, all the remainder of the twig being the green succulent growth of the present year. She places her egg near the tip of this twig, in the angle where one of the leaf-stalks branch off from it. The young worm which hatches therefrom sinks himself into the center of the twig and feeds upon the soft pulpy tissue around him until it is all consumed, leaving only the green outer bark, which is so thin and tender that it withers and dries up, and ere long becomes broken. By the time this green tender end of the twig is consumed the worm has acquired sufficient size and strength to attack the more solid woody portion forming its lower end. He accordingly eats his way downward in the center of the twig, consuming the pith, to its base, and onward into the main limb from which this twig grows, extending his burrow obliquely downward to the center of the limb, to a distance of half an inch or an inch below the point where the lateral twig is given off.

The worm being about half grown, is now ready to cut the limb asunder. But this is a most nice and critical operation, requiring much skill and calculation; for the limb must not break and fall while he is in the act of gnawing it apart, or he will be crushed by being at the point where it bends and tears asunder, or will fall from the cavity there when it breaks open and separates. To avoid such casualties, therefore, he must after severing it have time to withdraw himself back into his hole in the limb and plug the opening behind him before the limb breaks and falls. And this little creature accordingly appears to be so much of a philosopher as to understand the force of the winds and their action upon the limbs of the tree, so that he can bring them into his service. He accordingly severs the limb so far that it will remain in its position until a strong gust of wind strikes it, whereupon it will break off and fall.

But the most astonishing part of this feat remains to be noticed. The limb which he cuts off is sometimes only a foot in length and is consequently quite light; sometimes ten feet long, loaded with leaves, and very heavy. A man by carefully inspecting the length of the limb, the size of its branches, and the amount of foliage growing upon them could judge how far it should be severed to insure its being afterwards broken by the winds. But this worm is imprisoned in a dark cell only an inch or two long in the interior of the limb. How is it possible for this creature, therefore, to know the length and weight of the limb and how far it should be cut asunder? A man, moreover, on cutting a number of limbs of different lengths, so far that they will be broken by the winds, will find that he has often miscalculated, and that several of the limbs do not break off as he designed they should. This little worm, however, never

makes a mistake of this kind. If the limb be short it severs all the woody fibers, leaving it hanging only by the outer bark. If it be longer a few of the woody fibers on its upper side are left uncut in addition to the bark. If it be very long and heavy not more than three-fourths of the wood will be severed. The annexed figures represent the several ends of limbs of different sizes, the coarsely dotted parts of the two first indicating the ragged broken ends of the woody fibers, the remainder being the smooth surface cut by the worms, and the large black dot representing the perforation leading up the limb to where the worm lies. The first of these figures was taken from the limb already spoken of as ten feet in length, and here it will be noticed that a portion of the stouter wood towards the center of the limb was preserved, as though the worm had been aware that the weaker sappy fibers outside next to the bark could not be relied upon for sustaining a limb of this size, as they are where the limb is smaller. With such consummate skill and seemingly superterrestrial intelligence does this philosophical little carpenter vary his proceedings to meet the circumstances of his situation in each particular case! But by tracing the next stage of his life we shall be able to see how it is that he probably performs these feats which appear so much beyond his sphere.

Having cut the limb asunder so far that he supposes it will break with the next wind which arises, the worm withdraws himself into his burrow, and that he may not be stunned and drop therefrom should the limb strike the earth with violence when it falls, he closes the opening behind him by inserting therein a wad formed of elastic fibers of wood. He now feeds at his leisure upon the pith of the main limb, hereby extending his burrow up this limb six or twelve inches or more, until he attains his full growth—quietly awaiting the fall of the limb, and his descent therein to the ground. It is quite probable that he does not always sever the limb sufficiently, in the first instance, for it to break and fall. Having cut it so much as he deems prudent, he withdraws and commences feeding upon the pith of the limb above the place where it is partially severed, until a high wind occurs. If the limb is not hereby broken, as soon as the weather becomes calm he very probably returns and gnaws off an additional portion of the wood, repeating this act again and again, it may be, until a wind comes which accomplishes the desired result. And this serves to explain to us why it is that the worm severs the limbs at such an early period of his life. For the formidable undertaking of cutting asunder such an extent of hard woody substance, we should expect he would await till he was almost grown and had attained his full strength and vigor. But by entering upon this task when he is but half grown he has ample opportunity to watch the result, and to return and perfect the work if he discovers his first essay fails to accomplish the end he has in view.

Thus the first part of the life of this worm is passed in a small twig branching off from the main limb. This is so slender and delicate that on being mined as it is by the worm and all its green outer end consumed, it dies and becomes so decayed and brittle that it is usually broken off when the limb falls, whereby it has escaped the notice of writers, hitherto. The remainder of his larva life is passed in the main limb, first cutting off this limb sufficiently for it to break with the force of the winds, and then excavating a burrow upwards in the center of the limb, both before and after it has fallen to the ground, feeding hereon until he has grown to his full size.

It is most frequently the limbs of the red and the black oak that I have met with, severed by the oak pruner, though it is not rare to find those of the scarlet oak (*Q. coccinea*) and of the white oak lopped off in the same manner. Limbs of the beech and chestnut not unfrequently, and those of the birch, the apple, and probably of other trees, are sometimes similarly severed. Mr. P. Weter, of Tirade, Walworth County, Wisconsin, informs me that the peach in his vicinity suffers in a similar manner, and to such an extent some years, that the severed limbs, varying from a few inches to two feet in length, are seen lying under almost every tree. We have in our country several species of beetles very closely related to the oak pruner, but no attempts have yet been made to ascertain their mode of life. It is very probable that

they all have this same habit of cutting off the limbs of trees, one perhaps preferring the wood of one kind of tree, another, another. This is the more probable, since there is considerable diversity in their operations, as shown by an examination of the fallen limbs. Thus the scarlet oak, instead of having a hole bored in the severed end of its limbs, commonly has half the wood ate away on one side of the limb for the length of an inch or more, with the cavity thus formed under the bark packed with worm dust, and a cylindrical burrow from the upper end of this cavity running upwards in the center of the limb, the same as in other cases.

It further appears that the female, when ready to drop an egg, is not always able to find a small twig with a green succulent end adapted to her wants. She then consigns her progeny to the bark of the main limb, and the young worm subsists on the soft pulpy matter between the bark and the wood, excavating a shallow irregular cavity which is packed with worm dust, till it has acquired sufficient strength to gnaw the wood, when it cuts off the limb as in other cases. It may, however, be a different species from the common oak pruner, which cradles its young thus beneath the bark instead of in a lateral twig. It is usually in the fallen limbs of the beech, though sometimes in those of the oaks also, that I have met with these worm tracks under the bark.

The bark of the beech, it will be recollected, is quite thin and very brittle, so that it will ill serve to hold the limb in its place if the wood underneath is cut off in the usual manner. And accordingly a remarkable modification of this operation will be noticed in the amputated limbs of this tree. The worm eats its way down the limb beneath the bark until it has acquired sufficient strength to sever the woody fibers. It then passes transversely around the limb beneath the bark, girdling it by cutting off all the softer outer fibers and leaving the harder ones in the middle of the limb uncut, whereby the limb is sustained until the wind strikes it. How surprising that these little creatures have such intelligence given them as enables them to vary their operations to such an extent, according to the circumstances of their situation in each particular case! I should be inclined to think the beech pruner a different species from that of the oak, as it dwells beneath the bark instead of in a lateral twig, and cuts off the outer instead of the inner wood of the limb; but the worm is identical with that of the oak in its external appearance, and one of these worms which I placed in a cage, falling from its fractured burrow in the beech limb, forsook this wood and commenced boring into an oak limb lying beside it.

Not only the limbs but small young trees, at least of the white oak, are sometimes felled by these insects; in which cases the worm, instead of cutting the wood off transversely, severs it in a slanting or oblique direction, as though it were aware the winds would prostrate a perpendicular shoot more readily by its being cut in this manner.

The larva grows to a length of 0.60, and is then 0.15 thick across its neck, where it is broadest. It tapers slightly from its neck backwards, the hind part of its body being nearly cylindrical. It is a soft or fleshy grub, somewhat shining and of a white color, often slightly tinged with yellow, its head, which is small and retracted into the neck, being black in front. It is divided into twelve rings by very deep, wide, transverse grooves. The neck or first ring is much the largest, and shows two very pale tawny yellow bands on its upper side, the anterior one slightly broken asunder in its middle, and on each side beyond the ends of these bands is a spot of the same color. The two or three rings next to the neck are shorter than the others, and less widely separated from each other. A faint stripe of a darker color may be discerned along the middle of the back, widely broken apart at each of the sutures. The last ring is much narrower and more shining than the others, and is cut across by a fine transverse line, dividing it into two parts, of which the hinder one or tip is bearded with small blackish hairs, and a few fine hairs are perceptible upon the other rings. The two last rings are retracted into the ring which precedes them, at the pleasure of the animal, whereby this ring becomes humped and swollen; and it appears to be chiefly

by thus enlarging the end of its body that the worm holds and moves itself about in its cell, its feet being so weak and minute that they are scarcely perceptible and can be of little service. It has three pairs of soft conical jointed feet, resembling its antennæ in their size and shape. The first pair is placed on an elevated wrinkle of the skin in the suture between the first and second segments of the thorax, more distant from each other than are those of the second and third pairs, which are situated on the middle of the elevation of the second and third segments.

Some of the worms enter their pupa state the last of autumn, and others not till the following spring. Hence in examining the fallen limbs in the winter, a larva may be found in one, a pupa in another. Preparatory to entering its pupa state, the larva places a small wad of woody fibers, sometimes intermingled with worm-dust, below it, in its burrow, and sometimes another wad above it if the burrow runs far up the limb, thus partitioning off a room one or two inches in length in which to lie during its pupa state. The shriveled cast skin of the larva will be found at the upper end of this cell, after it has changed to a pupa.

Usually those insects which undergo a complete metamorphosis, remain at rest, lying dormant and motionless during their pupa state. The oak pruner, however, is a remarkable exception to this. Whenever its cell is opened it will be seen moving from one end of it to the other with quite as much agility as it shows in its larva state. The sutures of its abdomen have the same deep transverse grooves as in the larvæ, admitting the same amount of motion to this part of its body that it previously had. And lying on its back, it uses the tip of its abdomen as though it were furnished with a proleg, the little sharp points with which it is covered being pressed against the rough walls of the cell, and the body pushed forward or drawn backward hereby, step after step, at the will of the animal.

The pupa is of much the same size with the larva and of a yellowish white color. Its eyes are sometimes white, sometimes blackish brown. The antenna-sheaths arise in the notch upon the inner side of the eyes and, passing directly across the surface of these organs, extend down along each side of the back above the sheath of the fore and middle pairs of legs, then curving inward they pass back to the eye along the inner side of the same legs, their ends being placed upon the eye slightly inside of their origin. The knees of the hind legs protrude far out from under the upper sides of the wing-sheaths forward of their tips, whilst the feet of these legs occupy the space between the tips of the wing-sheaths. The back of the abdomen shows a distinct pale brown stripe along the middle, on each side of which the surface of the segments is furnished with numerous small erect sharp points of a dark brown color, those on the apical segment being double the length of the others.

The beetle.—They are usually from 0.50 to 0.55 in length and 0.12 broad, of a slender cylindrical form, of a dull black color, tinged more or less with brown on the wing-covers, more evidently so towards their tips, whilst the antennæ are paler brown, and the under side and legs chestnut colored, sometimes bright, sometimes dark and blackish. The surface is everywhere clothed with shortish prostrate gray hairs, and on the wing-covers these are in places more dense, forming small gray spots, and on each side of the thorax, in the middle, is a whitish dot, formed in the same manner. Sometimes also on the base of the thorax, on each side of its middle, a short gray stripe formed by these hairs, is very obvious, whilst in other individuals no traces of these stripes can be discerned.

The scutellum also is densely covered and gray from these hairs. The surface, above, is occupied by numerous coarse round punctures, those on the thorax being of the same size with those on the wing-covers, but more crowded, many of them running into each other. Towards the tips of the wing-covers these punctures become perceptibly smaller.

In at least three-fourths of the fallen limbs no worm is to be found; and an examination of them shows that the insect perished at the time the limb was severed, and before it had excavated any burrow upward in its center, no perforation being present

except that leading into the lateral twig. It is probable that in many of these instances the limb broke when the worm was in the act of gnawing it asunder, either from its own weight or from a wind arising whilst the work was in progress. And even though the worm may have withdrawn into its hole and plugged the opening behind it, it is frequently discovered here, probably, and devoured by birds. After a violent wind in the summer season, some of our insect-eating birds may always be noticed actively in search of limbs and trees that have thereby been broken, their instinct teaching them that this breakage usually occurs from the wood being weakened by the mining operations of worms therein, whose lurking places are now opened to them. And they will be seen industriously occupied in picking around the fractured ends of the wood, and feasting upon the grubs which they there find. Numbers of our wood-boring larvæ are thus destroyed, and the oak pruner, notwithstanding the precautions it takes to secret itself, doubtless frequently falls a prey to these sagacious foragers.

Remedies.—These insects will undoubtedly at times occur in such numbers as to render it important that they be destroyed, at least where they resort to the peach or other valuable trees. And this may readily be effected by gathering and burning the fallen limbs in the winter or the early part of spring.

24. THE SEVENTEEN-YEAR LOCUST.

Cicada septemdecim Linn.

Order HEMIPTERA ; family CICADARIE.

Stinging the terminal twigs of the oak and other forest trees and of various fruit-trees, the seventeen-year locust, which deposits its long slender eggs in a broken line along the twig.

Without attempting to recapitulate the history of this famous insect, we would only say that the eggs are deposited from the end of May through June (Fig. 9, *d, e*), in pairs in the terminal twigs of the oak, &c. The larvæ (Fig. 9, *f*), hatch out in about six weeks after they are deposited, and drop to the ground, in which they live, sucking the roots of trees, &c., for nearly seventeen years, the pupa state (Fig. 9, *a, b*) lasting but a few days.

The following remarks on the habits of this insect are taken from our Third Report on the injurious Insects of Massachusetts :

As regards the kinds of trees stung by the Cicada I may quote from a communication from William Kite in the American Naturalist, vol. ii, p. 442, as confirming and adding somewhat to Dr. Harris's statements: "Seeing in the July number of the Naturalist a request for twigs of oak which had been stung by the so-called seventeen-year locust, I take the liberty of sending you twigs from eleven different varieties of trees in which the females have deposited their eggs. I do this to show that the insect seems indifferent to the kind of wood made use of as a depository of her eggs. These were gathered July 1, in about an hour's time, on the south hills of the 'Great Chester Valley,' Chester County, Pa. No doubt the number of trees and bushes might be much increased. The female, in depositing her eggs, seems to prefer well-matured wood, rejecting the growing branch of this year, and using the last year's wood and frequently that of the year before, as some of the twigs inclosed will show. An orchard which I visited was so badly 'stung' that the apple trees will be seriously injured, and the peach trees will hardly survive their treatment. Instinct did not seem to caution the animal against using improper depositories, as I found many cherry trees had been used by them, the gum exuding from the wounds, in that case sealing the eggs in beyond escape.

"The males have begun to die, and are found in numbers under the trees; the females are yet busy with their peculiar office. The length of wood perforated on each branch varied from one to two and a half feet averaging probably eighteen inches; these seemed to be the work of one insect on each twig, showing a wonderful fecundity.

"The recurrence of three 'locust-years' is well remembered in this locality—1834, 1851 and 1868. There has been no variation from the usual time, establishing the regularity of their periodical appearance."

As regards the time and mode of hatching, Mr. S. S. Rathvon, of Lancaster, Pa., contributes to the same journal some new and valuable facts, which we quote: "With reference to the eggs and young of the seventeen-year cicada, your correspondent from Haverford College, Philadelphia, is not the only one who has failed to produce the young by keeping branches containing eggs in their studios. I so failed in 1834 and 1851, and indeed I have never heard that any one has succeeded in that way, who has kept them for any great length of time. In the brood of 1868, the first cicadas appeared here in a body, on the evening of the second day of June. The first pair in *coitu*, I observed on the 21st, and the first female depositing on the 26th of the same month. The first young were excluded on the 5th of August. All these dates are some ten days later than corresponding observations made by myself and others in former years. On the 15th of July I cut off some apple, pear, and chestnut twigs containing eggs, and stuck the ends into a bottle containing water, and set it in a broad, shallow dish also filled with water, the whole remaining out of doors exposed to the weather, whatever it might be. The young continued to drop out on the water in the dish for a full week, after the date above mentioned. I could breed no cicadas from branches that were dead and on which the leaves were withered, nor from those that from any cause had fallen to the ground, and this was also the case with Mr. Vincent Bernard, of Kennet Square, Chester County, Pa. After the precise time was known, fresh branches were obtained, and then the young cicadas were seen coming forth in great numbers, by half a dozen observers in this county. As the fruitful eggs were at least a third larger than they were when first deposited, I infer that they require the moisture contained in living wood to preserve their vitality. When the proper time arrives and the proper conditions are preserved, they are easily bred, and indeed I have seen them evolve on the palm of my hand. The eyes of the young cicadas are seen through the egg-skin before it is broken."

Mr. Riley, in an interesting account of this cicada in his First Annual Report on Noxious, Beneficial, and Other Insects of Missouri for 1869, has shown that in the Southern States thirteen-year broods of this insect are found. He remarks: "It was my good fortune to observe that besides the seventeen-year broods, the appearance of one of which was recorded as long ago as 1633, there are also thirteen-year broods, and that, though both sometimes occur in the same States, yet, in general terms, the seventeen-year broods may be said to belong to the Northern and the thirteen-year broods to the Southern States, the dividing line being about latitude 38°, though in some places the seventeen-year brood extends below this line, while in Illinois the thirteen-year brood runs up considerably beyond it. It was also exceedingly gratifying to find, four months after I had published this fact, that the same discovery had been made years before by Dr. Smith, though it had never been given to the world."

Mr. Riley predicts that in Southern New England a brood will appear in 1877 and 1885. Probably the Plymouth brood, which appeared in 1872, will not appear again for seventeen years, namely, in 1889, the two broods noticed by Riley appearing west of this town. As regards its appearance in Plymouth, Mass., Harris states that it appeared there in 1633. The next date given is 1804, "but, if the exact period of seventeen years had been observed, they should have returned in 1803."

Mr. B. M. Watson informs me, from his personal observation, that it also appeared in 1838, 1855, and 1872. In Sandwich it appeared in 1787, 1804, and 1821. In Fall River it appeared in 1831, in Hadley in 1812, in Bristol County in 1784, so that, as re-

marked by Harris and others, it appears at different years in places not far from each other. So that while in Plymouth and Sandwich we may look for its reappearance in 1889, in Fall River it will come in 1885, or four years earlier.

There are three species of *Cicada* in the Northern States, and, in order that they may not be confounded in studying the times of appearance of the different broods of the seventeen-year species, I add a short description of each form, so that they may be readily recognized in the winged and immature states.

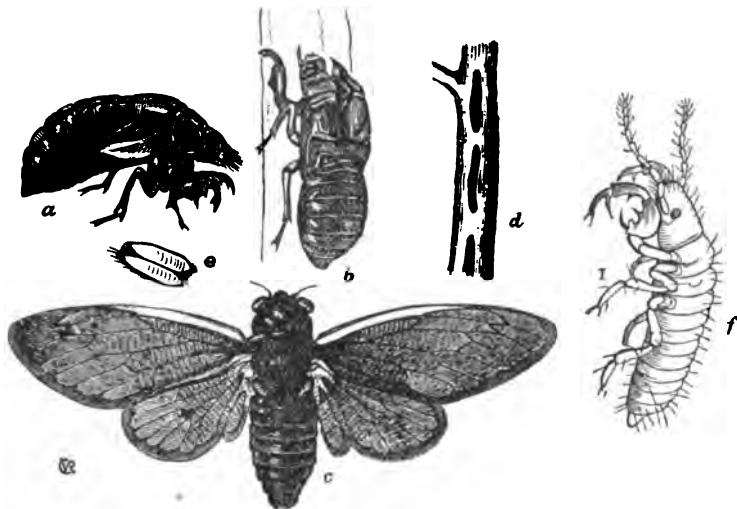


FIG. 9.—The seventeen-year *Cicada* and pupa; (a, b, d, position of eggs (e); f, larva.—After Riley.

The two larger species are the seventeen-year locust (*Cicada septendecim*) and the dog-day cicada (*C. pruinosa*). Fig. 9, copied from Riley's report, gives a good idea of the former species: a represents the pupa, b the same after the adult has escaped through the rent in the back, c the winged fly, d the holes in which the eggs e are inserted. Fig. 9, f represents the larva as soon as hatched. The adult may be known by its rather narrow head, the black body, and bright red veins of the wings. The wings expand from two and a half to three and a quarter inches.

The pupa is long and narrow, and compared with that of *C. pruinosa* the head is longer and narrower, the antennae considerably longer, the separate joints being longer than those of the dog-day locust. The anterior thighs (femora) are very large and swollen, smaller than in *C. pruinosa*, though not quite so thick, with the basal spine shorter than in that species, while the snag or supplementary tooth is larger and nearer the end; the next spine, the basal one of the series of five, is three times as large as the next one, while in *C. pruinosa* it is of the same size, or, if anything, smaller. The toe joint (tarsus) projects over two-thirds of the length beyond the end of the shank (tibia), while in the other species it only projects half its length. The terminal segment of the body is rather larger than in *C. pruinosa*. The body is shining gum-color or honey-yellow, with the hinder edge of the abdominal segments thickened, but no darker than the rest of the body. Length, one inch (.90–1.00); width, about a third of an inch (.35), being rather smaller than that of *C. pruinosa* and much larger than that of *C. rimosa*.

25. THE WHITE-LINED TREE HOPPER.

Thelia univittata Harris.

Order HEMIPTERA; family MEMBRACIDÆ.

Common upon oak limbs and twigs, puncturing them and sucking their juices.

This tree hopper is found on the oak in July. It is about four-tenths

of an inch in length; the thorax is brown, has a short obtuse horn extending obliquely upwards from in front, and there is a white line on the back extending from the top of the horn to the hinder extremity. (Harris.)

26. THE OAK BLIGHT.

Eriosoma quercu Fitch.

Order HEMIPTERA; family APHIDÆ.

A species of blight, or a wooly aphid upon oak limbs, puncturing them and exhausting them of their sap.

This blight is very like a similar insect upon the basswood. The winged individuals are black throughout, and slightly dusted over with an ash-gray powder resembling mold. The fore wings are clear and glassy, with their stigma-spot dusky and feebly transparent, their rib-vein black, and their third oblique vein abortive nearly or quite to the fork. It is 0.16 long to the tips of its wings. (Fitch.)

27. THE WHITE OAK SCALE-INSECT.

Lecanium quercifex Fitch.

Order HEMIPTERA; family COCCIDÆ.

Adhering to the smooth bark of the limbs of the white oak, in June, an oval, convex, brownish-black scale, about 0.30 inch long and 0.18 wide, its margin paler and dull yellowish. (Fitch.)

28. THE QUERCITRON SCALE-INSECT.

Lecanium quercitronis Fitch.

Order HEMIPTERA; family COCCIDÆ.

On the small limbs of the black oak, a scale like the preceding but smaller, and of a nearly hemispherical form; its color varying from brownish-black to dull reddish and pale dull yellow, with a more or less distinct stripe of paler yellow along the middle of its back, and the paler individuals usually mottled with black spots or stripes. Length, 0.20; width, 0.16 inch. (Fitch.)

These scales are parasitized by *Platygaster lecanii* Fitch.

29. THE OAK-TUMOR GALL-FLY.

Cynips quercus-tuber Fitch.

Order HYMENOPTERA; family CYNIPIDÆ.

On or near the ends of the small limbs and twigs of the white oak, hard irregular swellings thrice as thick as the twig below them, the bark upon them of a brighter cherry-red color than elsewhere, and their substance internally corky and woody; produced by the stings of a small black gall-fly with dull pale yellow antennæ, mouth and legs, its hind shanks and its antennæ towards their tips being dusky, its length 0.08 and to the tips of its wings 0.13. (Fitch.)

30. THE OAK-TREE GALL-FLY.

Cynips quercus-arbores Fitch.

Order HYMENOPTERA; family CYNIPIDÆ.

Swellings similar to those above described, growing on the tips of the limbs of aged and large white-oak trees; producing a small black gall-fly having all its legs and

antennæ of a bright pale yellow color, and one more joint in the latter organs than in the preceding species in the males, which sex is 0.06 in length, and to the tips of its wings 0.10. (Fitch.)

31. THE OAK-POTATO GALL-FLY.

Cynips quercus-batatus Fitch.

Order HYMENOPTERA; family CYNIPIDÆ.

A large, hard, uneven swelling, three-fourths of an inch thick and twice or thrice as long, resembling a potato in its shape, growing on white-oak twigs more distant from their ends than the oak-tumor; producing a small black gall-fly with the basal joints of its antennæ and its legs dull pale yellow, its thighs and hind shanks black, and its middle shanks often dusky, the antennæ in the female with thirteen joints, and the length of this sex 0.09. (Fitch.)

32. THE OAK-BULLET GALL-FLIES.

Callaspidia quercus-globulus Fitch, and *Cynips oneratus* Harris.

Order HYMENOPTERA; family CYNIPIDÆ.

Smooth globular galls the size of a bullet, growing singly, or two, three or more in a cluster, upon white-oak twigs, internally of a corky texture, each containing in its center a single worm, lying in an oval whitish shell resembling a little egg 0.15 in length; producing sometimes a black gall-fly with tawny-red legs and the second veinlet of its wings elbowed or angularly bent backwards, its length 0.15; sometimes a smaller fly (*C. oneratus*) of a clear pale yellow color, almost white, with a broad black stripe the whole length of its back, which color in the males is more extended, reaching down upon the sides, its length 0.12. (Fitch.)

These species are parasitized by two chalcid flies, *Macroglenes querciglobuli* Fitch, and *Pteromalus onerati* Fitch.

33. THE OAK-FIG GALL-FLY.

Cynips quercus-ficus Fitch.

Order HYMENOPTERA; family CYNIPIDÆ.

Surrounding the twigs of white oaks in a dense cluster, resembling preserved figs packed in boxes, each molded to the shape of those pressing against its sides, hollow bladder-like galls of the pale dull yellow color of a faded oak leaf, each gall producing a small black fly with the lower half of its head, its antennæ and legs pale dull yellow, its hind shanks dusky and its abdomen beneath reddish-brown, its antennæ with fifteen and in the female thirteen joints. Length 0.06, females 0.10, and to the end of their wings 0.14. (Fitch.)

34. THE WOOL-SOWER GALL-FLY.

Cynips seminator Harris.

Order HYMENOPTERA; family CYNIPIDÆ.

A round mass resembling wool, from the size of a walnut to that of a goose egg, growing on the side of or surrounding white-oak twigs in June, of a pure white color, or tinged or speckled with rose-red, and in autumn the color of sponge; producing small shining black gall-flies with bright tawny yellow legs and antennæ, and in the female the head and thorax cinnamon-red; their antennæ of fifteen and fourteen joints; length 0.08, and females 0.11 inch. (Fitch.)

INJURING THE LEAVES.

35. THE FOREST TENT CATERPILLAR.

Clisiocampa disstria Hübner; (*Clisiocampa sylvatica* Harris).

Order LEPIDOPTERA; family BOMBYCIDÆ.

A caterpillar like the apple-tree tent-caterpillar, but differing from it in having a row of oval white spots instead of a white stripe along its back; the colony spinning a cobweb-like nest against the side of the tree; spinning a whitish cocoon, the moth appearing early in July.

The nests of this caterpillar, unlike the prominent tents of *C. americana*, so abundant in wild-cherry trees and neglected orchards, are seldom seen, as they are of so slight a texture and are so much less conspicuous objects than the tent-like whitish nests of *C. americana*; but the caterpillars are not infrequently met with. After spinning, about the middle of June in the Northern States, a dense oblong cocoon, the caterpillar lies in it about twenty days, the moth appearing the early part of July. It occurs in the Atlantic and Southern States. Fitch states that it also occurs on the apple and cherry, the walnut, and other trees. Mr. Riley informs me that this is as destructive as any caterpillar to the foliage of the oak in the Southern States, being far more injurious than stated by Fitch, who quotes with disapproval Abbot's statement (Insects of Georgia, p. 117) that they are "sometimes so plentiful in Virginia as to strip the oak trees bare."

The caterpillar.—Pale blue, sprinkled over with black points and dots. Along the middle of the back is a row of ten or eleven oval or diamond-shaped white spots; behind each of these spots is a much smaller white spot, occupying the middle of each segment. On the hinder part of each wing are three crinkled and more or less pale orange-yellow lines, which are edged with black. On each side also is a continuous and somewhat broader

stripe of the same yellow color, similarly edged on each side with black. Lower down on each side of the body is a paler yellow or cream-colored stripe, the edges of which are more jagged and irregular than those of the one above it. Length 1.50 inches. (Fitch.)

The male moth usually measures 1.20 across its spread wings. Its thorax is densely coated with soft hairs of a nankin-yellow color.

Its abdomen is covered with shorter hairs, which are light amber or cinnamon brown on the back and tip and paler or nankin yellow on the sides. The antennæ are gray, freckled with brown scales, and their branches are very dark brown. The face is brown with the tips of the feelers pale gray. The fore wings are gray, varied more or less with nankin yellow, and they are divided into three nearly equal portions by two straight dark brown lines, which cross them obliquely, parallel with each other and with the hind margin. The space between these lines is usually brownish and darker than the rest of the wing, being quite often

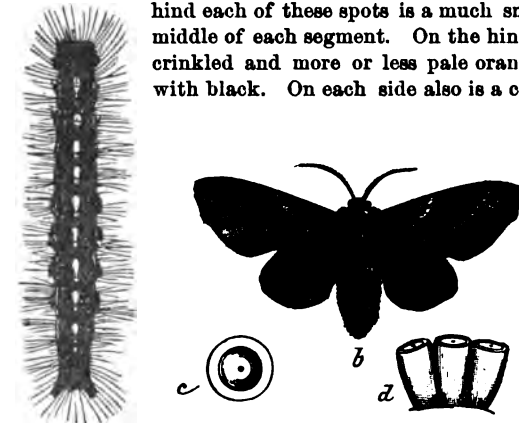


FIG. 10.—Caterpillar; b, female moth; c, d, egg of the oak tent-caterpillar.—After Riley.

hairs, which are light amber or cinnamon brown on the back and tip and paler or nankin yellow on the sides. The antennæ are gray, freckled with brown scales, and their branches are very dark brown. The face is brown with the tips of the feelers pale gray. The fore wings are gray, varied more or less with nankin yellow, and they are divided into three nearly equal portions by two straight dark brown lines, which cross them obliquely, parallel with each other and with the hind margin. The space between these lines is usually brownish and darker than the rest of the wing, being quite often

of the same dark brown color as the lines, whereby they become wholly lost. Sometimes the hind stripe is perceptibly margined on its hind side by a pale yellowish line. The fringe is of the same dark brown color with the oblique lines, with two whitish alternations towards its outer end. But sometimes it is of the same color with the wings and edged along its tip with whitish. The hind wings are of a uniform pale umber or cinnamon brown, sometimes broadly grayish on the outer margin, and across their middle a faint darker brown band is usually perceptible, its edges on each side indefinite. The fringe is of the same color with the wings or slightly darker and is tipped with whitish. The under side is paler umber brown, the hind wings often gray, and both pairs are sometimes crossed by a narrow dark brown band, which on the hind wings are curved outside of the middle. All back of this band on both wings is often paler, and more so near the band.

The female is 1.75 in width, and, in addition to the shortness of the branches of her antennæ, differs from the male in her fore wings, which are proportionally narrower and longer, with their hind margin cut off more obliquely and slightly wavy along its edge. Hence, also, the dark brown lines cross the wings more obliquely, the hind one in particular forming a much more acute angle with the outer margin. And all the wing back of this line is sometimes paler or of a brownish ashy color. And the fringe of these wings has not the two whitish alternations which are often so conspicuous in the male. The head and fore part of the thorax is cinnamon brown. The abdomen is black, clothed with brown hairs, though very thinly so on the anterior part of each segment, where these hairs are intermingled with silvery gray scales. (Fitch.)

36. THE CALIFORNIAN TENT CATERPILLAR.

Clisiocampa californica Packard.

Feeding on the scrubby oak, in abundance near San Francisco, a tent-caterpillar with a black head and a double rusty black dorsal line, appearing from the middle of March till the middle of April.

"This species," says Mr. Stretch (in Papilio, vol. i, No. 5), "is exceedingly abundant in the neighborhood of San Francisco, and is probably widely distributed." Near San Francisco its favorite food-plant is a species of scrubby oak, *Q. agrifolia*, but it is sometimes found on the blackberry (*Rubus*) and other shrubby plants. Its depredations do not seem to have extended to the orchards. The nests may be seen in warm localities as early as the middle of March, while in those more exposed they are not seen till the middle of April; but both these dates are sufficiently early to protect the orchards. The larvæ pupate in about six weeks from the egg, and the imago appears in about a fortnight.

Larva.—Head black, legs black; abdominal feet pale testaceous. Body black, faintly dusted with rusty, which forms an exceedingly broken and indistinct lateral line, and a more complete double dorsal line. Each segment carries a lateral, transverse, very faint linear dot, above the lateral line. The dorsal and lateral hairs are all tawny. The general appearance of the larva is tawny brown. Length about 1.40 inches.

Cocoon.—Constructed in the crevices of bark or in the angles of masonry, where accessible, and consisting of a loose, white web, in which is suspended the long ovate cocoon of dense papery consistency, thickened with a yellowish powdery gum. (Stretch.)

37. THE PACIFIC OAK TENT CATERPILLAR.

Clisiocampa constricta Stretch.

Feeding on the leaves of the Sonoma oak of California, a tent-caterpillar, with an irregular black dorsal stripe and transforming at the end of May, the moth appearing late in June.

The following descriptions of larva, chrysalis, and cocoon of this moth is copied from Mr. Henry Edwards's account in the Proceedings of the California Academy of Sciences, vol. v, 1874, p. 368.

Larva.—Head slate-gray, with black spots; mouth-parts black, tipped with dull yellow. Body slate-gray, covered laterally with fine black speckles. Along the middle of the dorsal region is an irregular black stripe, marked on its sides with waved orange lines, and surmounted at the union of the segments by a double tuft of chestnut-brown hairs. On the second and third segments, in the middle of the notched black line, is a stripe of dull white. From the base of the orange-brown tufts spring a few scattered black hairs, longest anteriorly, and from the forepart of each segment arise lateral tufts of white hairs. The stigmata are orange, with black central points. Above the base of the feet is a black interrupted line, out of which spring other white hairs, irregularly disposed. Under side dull velvety black, with the anterior portion of each segment whitish. Feet and prolegs black, yellow at their tips. Length 1.85 inches. Food-plant, *Quercus sonomensis* Benth.

The larva is frequently attacked by a species of Ichneumon, the eggs of which are visible on the head and anterior segments.

Chrysalis.—Chestnut-brown, with few hairs along the base of each segment.

Cocoon.—Ovo-lanceolate, very silky, yellowish white, with some portions glued in compact mass, and whiter than the remainder. Chrysalis only imperfectly seen through the web. Larva May 22, changed to chrysalis May 29. Imago, June 16.

The caterpillar of a species of *Clisiocampa*, which differs from the two Californian species just described and from the eastern ones, the moth of which we did not obtain, was abundant at Virginia City and Helena, Mont., on the leaves of the wild rose so common near those towns, its conspicuous tents readily attracting the eye. A half-grown larva, found, June 16, at Virginia City, measuring 0.75 inch in length, had a blue-black head. The body was blue on the sides, with dark spots; a black subdorsal spot rudely resembling a St. George's cross occurred on each side of each ring. The median dorsal line is pale blue, interrupted by the sutures between the segments. On each side of the line is a brown ochreous patch. The hairs are ochreous brown; the long ones paler. When fully grown it is about the size of the Eastern tent-caterpillar (*C. americana*), *i. e.*, an inch and a half. The mature larva found at Helena, June 21, was described from life in my notes, as follows:

Head grayish brown; body pale, grayish-blue on the sides, speckled with black, with a large black squarish patch, extending above into the subdorsal broad longitudinal band, which is mottled with bright ochreous brown, short wavy lines. A pale bluish distinct longitudinal broad median dorsal stripe interrupted by the sutures between the segments. Hairs long, pale brown. Body blackish beneath.

At this date the caterpillars had begun to be full fed, and one caterpillar had spun a cocoon under a stone.

This caterpillar differs from that of *C. americana* in having a broad blue dorsal stripe instead of a white one, and there is no broad longitudinal black stripe, as in the Eastern caterpillar. The moth probably differs from any of the Pacific coast species, the larva being quite unlike that of *Clisiocampa californica* Pack., which is closely allied to *C. americana*. It also differs decidedly from the caterpillar of *C. constricta* Stretch, the dorsal stripe being blue instead of black.

38. THE CALIFORNIAN LAPPET-MOTH.

Gastropacha californica Pack.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Feeding in California on the oak as well as apple and pear trees, and spinning thin and irregular webs over the branches.

The larva, and pupa and cocoon have as yet not been described. I extract the following notice of its habits, by Mr. Henry Edwards:

The moth lays its eggs in June, and they must remain unhatched until the following spring. Just when the young shoots of the oaks (*Quercus agrifolia* Nee) begin to appear, the larvæ make their appearance also, spinning thin and irregular webs over the branches of the trees. In these webs they house mostly during the heat of the day, but sally forth in the evening and at night for food. In this way they will soon strip a tree of its leaves, though it is well to say that the oaks do not seem to be permanently affected, as they soon send forth fresh shoots, and toward the time that the caterpillars undergo their change to the chrysalis they are green and gay again. The larvæ retain the shelter of their web until after the third molt, when they wander away singly, are found everywhere, becoming sometimes a complete nuisance in gardens and fields. They feed in their more mature stages upon many plants besides the oak, eating with avidity willows, ash, *Æsculus californica*, *Phatnia arbutifolia*, *Arbutus menziesii*, as well as apple and pear trees. Toward the end of May they spin their cocoons, seeming to have no choice of locality, but fixing themselves wherever they may chance to be, either on walls, palings, trunks, or branches of trees, stems of grapes, or among the leaves of herbaceous plants. The time in the chrysalis state is about eighteen to twenty-one days, so that the moths emerge and are in the greatest abundance about the middle of June. They come very readily to light, and are a pest to the entomologist in his nocturnal rambles. I regret that I cannot now send you descriptions of the larva and chrysalis.

39. THE CALIFORNIAN PHRYGANIDEA.

Phryganidea californica Pack.

Order LEPIDOPTERA; family ZYGÆNIDÆ.

Very destructive to young oaks, a naked, yellowish-white caterpillar, striped with black and white, with a large head, wandering incessantly over the bushes and feeding very rapidly; spinning no cocoon, but the chrysalis, yellowish and black, attached by the tail to fences, &c.

This is, by its numbers and familiar habits, one of the best known and most destructive insects of California. The following account has been furnished me for Hayden's Report by Mr. Henry Edwards.*

This insect is also very destructive to our young oaks, the caterpillars, which are perfectly naked and with the head almost monstrous in size, making their appearance about the same time as those of *Gastropacha*. They are restless little creatures, wandering incessantly over the trees, and feeding very rapidly. They spin no cocoon, but hang by the tail, like the larva of *Vanessa*, &c. The change to the chrysalis is undergone in April and May, and the moths appear in about fifteen or sixteen days. There is a second brood of these insects, the imagoes of the latter appearing in September and October. Indeed, fresh specimens are now upon the wing, though the second brood is by no means so abundant as the first. I have observed that *Phryganidea* and



FIG. 11.—Californian Phryganidea.—From Packard.

* A. S. Packard, Jr., Report on the Rocky Mountain Locust, &c. Hayden's Report U. Geological Survey of the Territories for 1875.

Gastropacha never associate upon the same tree, and I think that the former has always the mastery. This is perhaps owing to some excretion from its body which is unpleasant to the *Gastropacha*; but of course I do not speak with certainty as to this fact. It is, however, sure that they are never found in large quantities on the same tree. I am inclined to think that *Phryganidea* is more destructive to the oaks than the other species, as it feeds solely upon *Quercus*, while the other, as I have said, is not so particular in the choice of its food. I inclose my published description of the eggs of *Phryganidea*. I quote Mr. Edwards's description of the egg and larva:

The egg is spherical, a little flattened above, shining, yellowish-white at exclusion, attached in clusters of about ten or twelve to the upper sides of the leaves. The third day the apex of the egg assumes a dull orange hue, afterwards changing to a bright reddish-purple and gradually to a duller shade as the young larvæ emerge. The eggs were laid by a female in my possession on July 5. In the young larva the head is very large, almost monstrous, pale olive-brown, with a narrow black line at base; body pale canary-yellow, with four rows of black spots arranged longitudinally in lines.

The larva is slender, with the head prominent, globose; last segment but one humped; head pale brown; body black above, dirty green below, with a broad dorsal line of dirty greenish, divided by three narrow black lines, and the sutures faintly marked with same color. There is also a narrow, broken, stigmal line of dirty greenish, and a similar line above each of the abdominal legs. Tip of the last segment horny, the segment not being used to assist in progression, but usually slightly elevated; body smooth, transversely wrinkled. Younger specimens chiefly differ in the disproportionate size of the head. Length 0.90 to 1.00 inch.

Pupa, naked, suspended by the tail, greenish white, with black markings; all the sutures of the head, thorax, legs, and antennæ lined with black. The mesothorax has a central black line; the abdomen has a dorsal row of black points on the front edge of each segment, and a lateral row blending into each other towards the anal segment, which is black; below with two sublateral series of black transverse spots nearly blending into two longitudinal bands. Length 0.75 inch. (Stretch.)

Mr. Behrens, of San Francisco, writes me that three generations of the *Phryganidea* appear in a year. "In 1875 it, with the larva of the *Gastropacha californica*, ate our evergreen oaks to broomsticks. You could hear the caterpillars eat and their manure drop, the latter covering everything; it could be swept together by the bushful. In the wake of both followed ichneumon parasites."

This singular insect was originally, from a study of the moth alone referred by me to the Psychinæ, but Mr. R. H. Stretch, with a knowledge of its transformations, has shown that I was in error, and has placed it very properly in the Zygaenidæ, in his valuable work entitled "Illustrations of the Zygaenidæ and Bombycidæ of North America" (1873). Having recently received specimens of the larvæ and pupæ from Mr. James Behrens, it was at once evident on a cursory examination that the early stages show all the characteristic features of *Alypia* and *Eudryas* and the other higher members of the Zygaenidæ. The venation of the moth is, however, aberrant, and this together with the dull-brown coloration and semi-hyaline wings misled me into placing it near *Psyche*.

40. THE ORANGE-STRIPED OAK-WORM.

Anisota senatoria Hübner.

Order LEPIDOPTERA; family BOMBYCIDÆ.

In August, sometimes stripping the trees, a spiny black caterpillar, with four orange-yellow stripes on the back and two along each side, with two black prickles above and two on each side, changing the following June to a large ochre-yellow moth, with a large white dot on the fore wings.

These prickly caterpillars, during certain years, as I have noticed at Amherst, Mass., so abound as to nearly strip large oak branches of their leaves, and is perhaps the most destructive of all our caterpillars to the foliage of the oak. The spines, if they happen to penetrate the skin, as Fitch and others have observed, sting like nettles. This species is the more injurious in the Northern States, while *A. stigma* is most destructive in the Southern, Mr. Riley informs me. According to Riley, Mr. Bassett has bred a small ichneumon fly (*Limneria* (Banchus) *fugitiva* Say) from this caterpillar. Riley has also bred it from the larva of *Anisota stigma*, as well as other caterpillars.

41. THE SPECKLED SPINY OAK-WORM.

Anisota stigma Hübner.

Eating the leaves in September, in the Southern States especially, a worm like the preceding, but of a bright tawny or orange color, with a dusky stripe along the back and dusky bands along the sides, and with its prickles lengthened into thorn-like points.

This worm is said by Mr. Riley to be nearly as destructive in the Southern States as *A. senatoria* is in the Northern.

Full-grown larva.—Average length, 50mm. General color pale tawny-red, inclining to orange. The whole surface covered with bright yellow, almost white papillæ of different sizes, giving a speckled appearance; the usual medio-dorsal narrow line; a broad subdorsal longitudinal stripe of a paler color and having a dingy caraneous hue; a narrower sub-stigmatal stripe of the same hue. Horns and spines black and marked with white papillæ, and with a tendency to branch, especially toward the tips; the longer horns on joint 2 being blunt-pointed, and also with white papillæ at the base. Head uniformly gamboge-yellow; cervical shield, anal plate, and plates on anal prolegs of the same yellowish color as head. A pale medio-ventral line; the thoracic legs pale, the prolegs with pale papillæ outside on a dark ground.

The species is at once distinguished from the other species of the genus by the longer spines, their tendency to furcation and being speckled with white papillæ, and by the less distinct striping. (Riley.)

42. THE ROSEY-STRIPED OAK-WORM.

Anisota pellucida Hübner.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Eating the leaves in July, in New York, a two-horned prickly worm of an obscure gray or greenish color, with dull brownish-yellow or rosy stripes, and its skin rough from white granules.

This species has been said by Fitch to have been common for many years in Salem, N. Y., where *A. stigma* has seldom been seen. The worms

mostly enter the ground to transform into the pupa early in August, though some remain on the trees as late as the middle of September.

The following description is copied from Prof. G. H. French's Report of the Curator of the Museum of the Southern Illinois Normal University, 1880. They occurred on different species of oak during the middle and last of September, most of them pupating by October 2d in the soil.

The caterpillar.—Length about 1.25 inches. General color pale dull green, striped with fine red substigmatal, subdorsal, and dorsal stripes, the last very pale, so as to be almost obsolete. Head with a slightly yellowish tinge. On each segment there are six short black thorns or sharp points, the two on the back of the second segment behind the head being about $\frac{1}{4}$ inch long, but the rest much shorter.

We add also the following description furnished by Mr. Riley, who has compared it with the caterpillar of *Anisota stigma*:

Pellucida comes nearest to *A. stigma* in general appearance, but the spines are shorter, more pointed, uniformly black; the color is darker, being almost black, so that the papillæ, which are rather denser, give the dark portion a bluish cast; the subdorsal and stigmatal lines are of a more intense red inclining to pink, and the stigmatal line is rather broader than the subdorsal. The average length is somewhat less and the larva more slender than in *stigma*; the shorter, blacker spines, deeper colors, and stronger contrast between the lines at once separating it from *stigma*. (Riley.)

43. THE OAK TUSOCK CATERPILLAR.

Halesidota maculata Harris.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Feeding in September, a black, very hairy caterpillar, with yellow and black tufts and yellow on the sides of the body; the worm spinning late in September a yellowish gray oval cocoon, constructed of silk, with the hairs of the caterpillar interwoven; the moth appearing the first week in June.

The larva.—Cylindrical; 1.30 inch long. Head large, slightly bilobed; black, with a faint white streak down the front as far as the middle, where it becomes forked. Body above black, thickly covered with tufts of bright yellow and black hairs. On the second, third, and fourth segments the hairs are mixed, yellow and black; those of the second and third segments, overhanging the head. From the fourth to the eleventh segments, inclusive, is a dorsal row of black tufts, the largest of which are on the tenth and eleventh segments; the fourth and eleventh segments have also a black tuft on each side near the base. The hairs on the sides of the body, from the fifth to the tenth segments, inclusive, are all bright yellow, while those on the sides of the twelfth and thirteenth are mixed with black. On the third, fourth, eleventh, and twelfth segments are a few long, spreading, yellow hairs, much longer than those elsewhere. (Saunders.)

The moth.—Light ocher-yellow, with large irregular light-brown spots on the fore wings, arranged almost in transverse bands. It expands nearly an inch and three-quarters. (Harris.)

44. THE OAK HETEROCAMPA.

Heterocampa pulverea Grote and Robinson.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Feeding on the red and scarlet oaks in southern Illinois a large bright-green caterpillar, the body deeper than broad, tapering a little from the middle to the head, but more behind, variously marked with purple and orange. (French.)

Professor French has reared this caterpillar, which occurred in Union County, Illinois, June 30th; July 6th it went into the dirt of the breeding-cage to pupate, the moth appearing August 6th.

The caterpillar.—Length, 1.25 inches. General color bright green, head gray, first segment behind the head with two dark purplish black dorsal warts; from these a purplish-brown line extends backward. This purple-brown color extends over the back part of the sixth segment, the whole of the seventh, and most of the eighth. On the third segment begins a dorsal orange-patch, which reaches back to the sixth segment, filling the space between the purple lines. On the ninth segment is another orange-patch. The tenth segment has no purple and only a little orange below the stigmata. There is also a faint yellowish dorsal line. The eleventh segment has purple-brown subdorsal lines with orange on the back. These lines unite on the twelfth segment and form a broad dorsal line. Feet and legs purple. (French.)

45. THE SIX-FLAPPED SLUG WORM.

Phobetrum pithecius Smith and Abbot.

Order LEPIDOPTERA; family BOMBYCIDÆ.

A singular dark-brown short, broad, ovate, flattened caterpillar, with six long, tongue-like, slender, fleshy lateral appendages, sometimes feeding on the oak.

This singular caterpillar, usually found on the plum, cherry, and apple; changes to a brown moth with very narrow wings. In the male the antennæ are very broadly pectinated, and the remarkably long narrow fore wings are partly transparent. Mr. Lintner has bred it from the oak.

46. *Cosmia orina* Guen.

Order LEPIDOPTERA; family NOCTUIDÆ.

A smooth yellowish-green larva, $\frac{3}{8}$ inch long, body cylindrical, above pale yellowish green, with a dorsal line of yellow, less distinct on the anterior segments, and covered with fine dots and short streaks of yellow, less numerous on the second and terminal segments. Head rather smooth, flattened in front, slightly bilobed, pale whitish-green. One specimen, which entered the chrysalis state on the 24th of June, produced the imago on the 18th of July. (Saunders.)

47. THE POLYPHEMUS SILK-WORM.

Teia polyphemus Hübner.

Feeding on the leaves in August and September, a large, fat, pale-green worm, as large as one's finger, with pearly red warts, with an oblique white line between the two lowermost warts; the head and feet brown, and a brown V-shaped line on the tail.

The American silk-worm, not uncommonly met with on the oak, may be artificially reared in great abundance on the oak, and the silk, reeled from the cocoons, can make a durable and useful cloth. The large, thick, oval cocoons are attached to the leaves and fall with them to the ground in autumn. The eggs are laid in June, when the moths may be seen

flying at night. It is one of our largest moths, expanding from five to six inches, and is dull ochereous-yellow, with a large transparent eye-

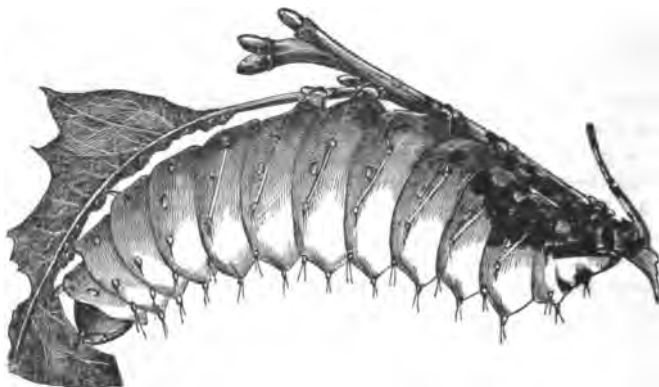


FIG. 12.—American silk worm, natural size.—From Packard.

like spot in the middle of each wing. It is not common enough to be destructive.

48. *Catocala fratercula* Grote and Robinson.

Order LEPIDOPTERA; family NOCTUIDÆ.

Living on the live oak in early spring in Florida, remaining in the pupa state two weeks. (A. Koebele, Bull. Brooklyn Ent. Soc. I, p. 44.)

49. THE SINGLE-DOTTED PARAPHIA.

Paraphia unipunctaria Haworth.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Eating the leaves early in June, a gray span worm 1.40 inch long, sprinkled with blackish dots and short lines, its head and neck a little thicker than the body, each ring with a small squarish white spot above on its hind edge and with two blackish parallel lines on each side of this spot.

This moth ranges from New England to Texas; it is said by Fitch to feed on the oak, and by Abbot (in Guenée) to live on the "elm, oak, *cournouiller*," &c. The *Amlapis triplipunctata* of Fitch is undoubtedly synonymous with Haworth's species, originally described as an English species.

The moth.—Of a uniform clear fawn-color, without the usual spots and speckles present in other species of the genus; a basal, brown hair-line bent outward acutely on the median vein; a broad, diffuse, dark median band common to both wings. The extradiscal line is dark, finely scalloped, curved outward below the costa, and sweeping inward below the first median venule; beyond this line both wings are deeper fawn-color. At a little distance below the costa, and nearer the extradiscal line than the outer edge of the wing, is a conspicuous angular, clear, white spot. Fringe dark, the scallops filled with whitish scales. Hind wings like the anterior pair, though the extradiscal line is not sinuous, but curved regularly outward. Beneath, paler than above; the median band is distinct, and the extradiscal line more or less so; the tints are much as above. The wings expand 1.40 inches.

49. THE HARLEQUIN OAK GEOMETER.

Aplodes mimosaria Guenée.

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding upon the leaves of the oak, a cylindrical brown geometric caterpillar, its back with singular curved lateral appendages, covered with short, velvety hairs, changing to a pale yellowish browner pupa, with a simple caudal spine, nearly $\frac{1}{2}$ an inch long. (Walsh).

The moth.—Male antennæ moderately pectinated, body and wings pea green, the wings broad, the hinder pair well rounded, less angulated than usual, anal angle square; head and antennæ white; front of the head bright rose-colored, except along the front edge. Palpi white, end of second joint and under side of the third joint roseate. Both pairs of wings crossed by linear, slightly-waved white lines. Inner line on the fore wings very near the base, regularly curved; outer line straight, waved, parallel with outer edge. Costa narrowly edged with white. Fringe white on both wings. Outer side of the fore femora green, of tibiæ dull red; two posterior pairs of tibiæ white. Abdomen white, green above at base, with a conspicuous white spot at base. Expanse of wings, 1 $\frac{1}{4}$ inches. Ranges from New England to the Middle and Western States.

50. THE LARGE SCALLOPED WINGED GEOMETER MOTH.

Stenotrachelys approximaria Guenée.

In the Southern States feeding on the oak a large geometer whose body is ash gray, washed with brown, with a dorsal series of white lozenges, lined with black and traversed in their middle by a twin, interrupted black vascular line. Found in March and April, the moth remaining in the chrysalis.

This caterpillar, according to Abbot (in Guenée), lives in Georgia on *Similax rotundifolia* and *laurifolia*, and, according to Abbot, on *Quercus*. This species is known to inhabit North Carolina as well as Georgia.

The moth.—It may be recognized by the deeply scalloped wings, and the large head, which is rather swollen in front. It is whitish gray, the wings clear, not bordered with brown. The fore wings with two distinct, heavy, black lines, the inner very near the base of the wing, regularly curved, a little pointed on the costa. Outer line bent at right angles on the basal third of the first median vein, the line thence going straight to the costa, though zigzag in its course; from the rectangular bend, the line follows a course subparallel to the median line, where it again turns rectangularly, ending on the middle of the inner edge of the wing. An inner reddish-brown line is parallel and near it below the median vein, and above passes just within the faint discal dot. Beyond this line the wing is speckled with transverse short, linear spots. A scalloped marginal, distinct black line. Expanse of wings, 1.90 inches.

51. THE TWO-LINED OAK GEOMETER MOTH.

Endropia bilinearia Packard.

A geometric caterpillar feeding on the oak; becoming a chrysalis early in July, emerging as a moth two weeks later.

The moth.—Clear fawn-brown; wings much darker and less spotted than in the other species of *Endropia*. Body and wings concolorous; front edge of the fore wings paler than the rest of the wing and spotted finely, especially on the edge, with brown specks. Two brown hair-lines, the inner situated on the basal, and the outer on the outer third of the wing; the inner line bent on the front edge of the wing. Outer line a little curved outward in the middle of the wing. Half-way between this line and the outer edge of the wing is a diffuse, interrupted, faint grayish band with a few dark scales, often wanting, and connecting with an oblique apical patch, also concolorous with the front edge of the wing. Outer edge of the wing deeply notched,

the eight acute points (including the apex, which is very acute) tipped with a few black scales, the fringe being whitish between. Beneath, body and wings ocher-yellow, especially in the middle of the wings. Both wings marked alike with a basal, diffuse, broad brown line, and an outer much curved brown hair-line. An outer row of dark patches forming a faint broken line. An apical, oblique, whitish patch. Hind edge of fore wings with darker spots and patches than elsewhere. Expanse of wings, 1.30-1.65 inches. This fine moth occurs all over the United States and on the Pacific coast from California to Oregon.

52. THE THREE-TOOTHED OAK GEOMETER MOTH.

Endropia pectinaria Guenée.

Living on the oak and other trees a large gray measuring worm, transforming to a large *Endropia*, with three sharp teeth in the hind wings.

The transformations of this moth have been observed by Abbot in Georgia, who found it living on the oak and poplar in April. It changes to a chrysalis at the beginning of May, and the moth appears at the end of the same month.

Larva.—Pale green, with the sutures and sides reddish, a double angle bordered with reddish on the second segment, another more salient on the sixth, and finally another on the tenth; the fifth has on each side a small pointed tubercle. Head and feet concolorous.

Moth.—The hind wings with a large tail and toothed; the fore wings angular, sickle-shaped. Body and wings pale whitish-ash. Wings thickly covered with fine speckles. Fore wings with three lines, the usual inner and outer line, and a third wavy submarginal hair-line. The two inner lines distinct, of even width, a little oblique, not waved; the innermost line situated exactly on the inner third, the outer line on the outer third of the wing. Front edge of the fore wings stained with reddish on the end of the outer line. Submarginal hair-line wavy, sinuate, reddish, situated half-way between the outer line and the edge of the wing, and disappearing below the second median venule, scalloped between each venule, much more distinct below than above. On the hind wings a single brown line, and traces of a submarginal wavy line. Beneath, paler than above, with the lines reproduced beneath, and dull colored; the third submarginal line on both wings partly obsolete, but clearer than above; fringe reddish. Expanse of wings 1.50 inches. Ranges from Maine to Missouri.

The parent of this caterpillar, which is found in the United States, north and south, and west as far as Kansas, may be known by the three well-marked teeth on the apical half of the hind wings, by the clear border of the wings, and the dark clear lines on the under side.

The caterpillar lives in Georgia on the oak and other trees, according to notes left after his death by Abbot, and is of a pale yellowish gray, with a dorsal lozenge-like mark. The 4th segment is darker, and on the back of the 8th, 9th, and 10th are also two obscure marks bifid anteriorly on the first, and carrying a blackish angle on each extremity of the second. The head and feet are concolorous. It is found in Georgia in May and June, and the moth is disclosed towards the end of this last month. A second generation enters the chrysalis state towards the middle of July to appear as moths in the beginning of August. In the Northern States the species is undoubtedly only single-brooded.

Besides these geometric caterpillars, that of *Metrocampa perlaria* Guenée should be looked for on the oak, as its closely allied European congener (*M. margaritata*) feeds on the elm, hornbeam, birch, and oak.

53. THE GREEN AND RED OAK SPAN WORM.

Metanema quercivoraria Guenée.

Feeding on the oak, a pale green span worm, marked with red, changing to a brownish gray chrysalis, from which a beautiful sickle-winged moth comes.

54. THE LEAF-ROLLING WEEVIL.

Attelabus bipustulatus Fabr.

Rolling up the leaves of the red, post, and laurel oak (*Q. imbricaria*), late in April, forming compact, cylindrical cases containing a single egg; the case dropping to the ground, the larva after hatching feeding on the food around it, and finally transforming into a long-snouted weevil. A second brood of larvæ in July. (Murtfeldt.)

This beetle has the curious habit of rolling up a leaf, trimming and tucking in the lower ends with her beak. The egg is first deposited near the tip of the leaf, and a little to one side; the blade of the leaf is then cut through on both sides of the midrib, about an inch and a half below; a row of punctures is made on each side of the midrib of the severed portion, which facilitates folding the leaf together, upper surface inside, after which the folded leaf is tightly rolled up from the apex to the transverse cut, bringing the egg in the center; the concluding operation is the tucking in and trimming off the irregularities of the ends. A few days after completion the cases, first observed the latter part of April, drop to the ground; by May 15 several larvæ hatched and fed on the dry substance of their nest, and by the end of May they pupate within the nest; this state lasted from five to seven days, the first beetles issuing by June 2, while a second brood of larvæ may be found early in July. (Murtfeldt.)

The larva.—Average dorsal length, 0.22 inch; diameter on abdominal segments, 0.06 inch, tapering anteriorly from fourth segment. Yellowish white; thoracic segments slightly depressed on the back and smaller beneath; abdominal segments convex above and flat beneath, each one divided into three irregular shallow transverse folds, lateral surfaces with a double row of smooth polished oval tubercles, most symmetrical in form and position from segments 4 to 11 inclusive; above the tubercles on each segment is a deep depression. Head horizontal, rounded, small, about half the diameter of segment next behind, into which it retreats; white, the mandibles and other mouth parts reddish brown, surrounded by long hairs.

The pupa is cream white, 0.12 inch long; abdominal segments sharply ridged; posterior extremity terminates in a pair of bristly points, white, tipped with brown.

The beetle is a small, highly polished black weevil, with two large orange-red spots at bases of the wing-cover. (Miss Murtfeldt.)

I have also found, May 30, on the leaves of the oak near Providence, the rolls made by a species of *Attelabus*, apparently, but they were slenderer than those of the *Attelabus* found upon the alder.

I have also found on the leaves of the oak at the end of May, near Providence, *Cryptorhynchus bisignatus* Say. It may prove to live at the expense of this tree.

55. THE WHITE BLOTCH OAK-LEAF MINER.

Lithocolletis hamadryadella Clemens.

Order LEPIDOPTERA; family TINEIDÆ.

Making a whitish blotch-like mine upon the upper surface of the leaves of different oaks, a minute, flat, horny, footless, active, brownish-yellow larva, which transforms within the mine in a delicate disc-like cocoon. (Comstock.)

Several species of oak are injured by this leaf miner, which ranges from New York to Washington. Sometimes each leaf will contain on an average four or five miners, and young shade trees are thus weakened by their attacks in June. There are in Washington five or six broods of moths. The best remedy is to collect and burn the fallen leaves in the spring, since they contain the worms in their final stage before transforming.

The moth has white front wings, with three broad irregular bronze bands across each one, each band being bordered with black on its inner side. The hind wings are silvery. The wings expand 0.28 inch. (Comstock.)

56. *Brachys arosa* Melsheimer.

Order COLEOPTERA ; family BUPRESTIDÆ.

I have found this small Buprestid upon the leaves of the oak early in summer in Maine, and late in May near Providence, R. I. It most probably mines the leaves of the oak, but its habits are not yet known.

(We introduce a cut of *B. æruginosa*, much enlarged, to illustrate a larva of this genus.)

57. FITCH'S OAK-LEAF MINER.

Lithocolletis fitchella Clemens.

Order LEPIDOPTERA ; family TINEIDÆ.

Forming a tent-like mine on the under surface of the leaves of different species of oaks, a minute, nearly cylindrical, white larva. (Comstock.)

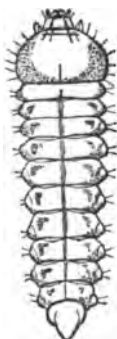


FIG. 13.—Larva of *Brachys æruginosa*.—From Packard.

The mine is visible on both sides of the leaf, while that of *L. hamadryadella* is to be seen only on the upper side. The insect hibernates in the pupa state within the leaves, so that the same general remedy of gathering and burning the leaves will apply to this as to the preceding leaf-miner.

The moth has pale reddish saffron fore wings, with a slight brassy hue. Along the front edge (costa) are five silvery-white costal streaks ; on the inner margin are two conspicuous silvery dorsal streaks, while the hind wings are grayish fuscous. (Comstock.)

58. THE OAK-LEAF PHYLLOXERA.

Phylloxera rileyi Lichtenstein.

Forming a yellow circular spot on the under side of the leaf, but showing plainly above, of the white and post oak ; the species of small size and unusually slender, and with long tubercles in the pupa. (Riley.)

INJURING THE SEED (ACORNS).

59. THE ACORN WORM.

Balaninus rectus Say.

Order COLEOPTERA ; family CURCULIONIDÆ.

A grub like the chestnut borer, boring into the acorns and transforming into a similar beetle, which is "easily distinguished from *B. nasutus* by the finer, more rectilinear

rostrum, and it always differs from *B. nasicus* in having no bands or *rittae*, the elytra being uniformly spotted, as in *sparsus* Schoen. This is the species I breed from acorns, and I believe it also infests hazel-nuts." (Riley.)

60. THE ACORN MOTH.

Holocera glandulella Riley.

Order LEPIDOPTERA; family TINEIDÆ.

Occupying the deserted holes of the acorn weevil, a narrow-winged moth which drops an egg in the hole, from which hatches a slender grayish white or yellowish worm with 16 legs and blue black dorsal marks, with a light brown conical shield and dusky anal plate. The moth with silvery-gray fore wings, marked with dull reddish; two distinct dark discal spots; a pale transverse stripe across the basal third of wing, slightly bent inwards at the middle; this stripe is well relieved behind by a dark shade, which generally extends from the bend to the costa above the discal spots, forming a more or less distinct triangular shade in the anterior middle portion of the wing.

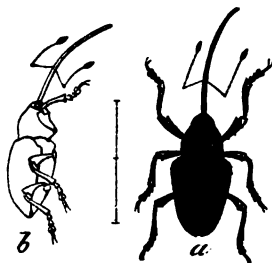


FIG. 14.—Acorn weevil. *Balaninus rectus*.—After Riley.

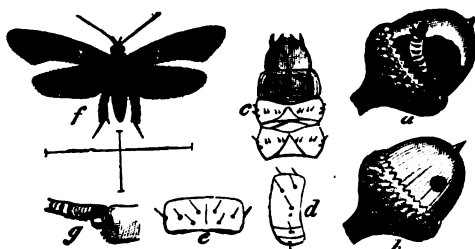


FIG. 15.—Acorn moth (f.); a, b, acorns containing the worm; c, front end of the worm; d and e, side and top view of a segment.—After Riley.

Hind wings brownish gray. Expanse of wings, 0.50–0.80 inch. (Riley.)

The following insects are also known to prey upon the oak :

LEPIDOPTERA.

61. The banded hair streak butterfly. *Thecla calamus* (Hübner).
62. Red spotted purple butterfly. *Basilarchia astyanax* (Fabr.).
63. Viceroy butterfly. *Basilarchia archippus* (Cramer).
64. Tiger swallow-tail. *Papilio glaucus* Linn.
65. Sleepy dusky-wing butterfly. *Thanaos brizo* Bard & Leconte.
66. Juvenal's dusky-wing. *Thanaos ennius* Scudd. Burgiss.
67. The oak tussock moth. *Halesidota tessellaris*. Basswood (Walsh).
68. The hickory tussock moth. *H. caryæ* Harris.
69. Clinton's tussock moth. *Parorgyia clintonii* G. & R. (Coquillet in Can. Ent., xii, 44).
70. The Io moth. *Hyperchiria io* (Fabr.).
71. The Maia moth. *Eucronia maia* (Drury).
72. *Heterocampa pulverea* G. & R. (French, Can. Ent., xii, 88.)
73. The oak slug worm. *Euclea monitor* Packard.
74. *Euclea querceti* (H. Sch.).
75. *Euclea quercicola* (H. Sch.). Allied to these is *Callochloa chloris* H. Sch., Fig. 16, the larva of which may be found on the oak.
76. *Edema albifrons* (Gm.-Abb.). (Harris' Correspondence, p. 304.)
77. *Nadata gibbosa* (Gm.-Abb.)? (Harris' Correspondence, p. 308.)

78. *Orgyia guloso* H. Edwards. (Edwards in Papilio, I, p. 61.)
 79. *Catocala coccinata* Grote. (Coquillett in Papilio, I, p. 56.)
 80. *Nematocampa filamentaria* Guenée. (Figured in Packard's Guide.
 81. *Therina endropiaria* Packard. (Goodell, Can. Ent., xi, 194.)
 82. *Dakrura pallida* Comstock.
 83. Oak-leaf Tortrix. *Argyrolepiæ quercifolia* Fitch, 5th Rep., p. 826.



FIG. 16.—*Callochloa chlorella*. Nat. size.

84. *Psilocorsis quercicella* Clemens.
 85. *Blastobasis coccivorella* Chambers.
 86. *Exartema inornatana* Clemens.

The following *Tineidæ* are said by Chambers to live on various species of oak :

Leaf-miners of the upper surface.

87. *Lithocolletis cincinnatiella* Chamb. Yellowish blotch mine.
 88. *Lithocolletis hamadryadella* Clem. Whitish blotch mine.
 89. *Lithocolletis tuliferella* Clem. } Mines as to form somewhat like the
 90. *Lithocolletis bifasciella* Chamb. } track made by a drop of water.
 91. *Lithocolletis bicolorella* Chamb. Yellowish blotch mine, like that of
 L. ulmella in elm.
 92. *Lithocolletis unifasciella* Chamb. } Irregular yellowish blotch mines,
 93. *Lithocolletis bethaneella* Chamb. } smaller than that of *cincinnatiella*,
 94. *Lithocolletis castaneæella* Chamb } and usually in red or black oaks
 95. *Tischeria zelleriella* Clem.
 96. *Tischeria pruinoseella* Chamb.
 97. *Tischeria castaneæella* Chamb.
 98. *Tischeria badiiella* Chamb.
 99. *Tischeria quercivorella* Chamb.
 100. *Tischeria quercitella* Clem.
 101. *Tischeria citrinipennella* Clem.
 102. *Tischeria complanoides* Frey & Boll. (Doubtful species.)
 103. *Tischeria concolor* Zeller. (Food plant uncertain.)
 104. *Tischeria tinctoriella* Chamb.
 105. *Nepticula platea* Clem. } Imago unknown. Larvæ of both in crooked,
 106. *Nepticula auguinella*. } linear mines.
 107. *Nepticula quercipulchella* Cham. }
 108. *Nepticula quercicostanella* Chamb. } Larvæ in crooked, linear mines.
 109. *Nepticula saginella* Clem.
 110. *Coriscium* sp. Imago unknown.
 111. *Coleophora querciella* Clem. Imago unknown. Larva lies in a case,
 which it attaches to the leaves.
 112. *Catastega timidella* Clem. Imago unknown.

Leaf-miners of the under surface.

113. *Lithocolletis quercitorum* Frey & Boll. } Tentiform mines.
 114. *Lithocolletis fitchella* Clem. }

- 115. *Lithocolletis basistrigella* Clem.
- 116. *Lithocolletis æriferella* Clem.
- 117. *Lithocolletis quercipulchella* Chamb.
- 118. *Lithocolletis quercialbella* Chamb.
- 119. *Lithocolletis fuscocostella* Chamb.
- 120. *Lithocolletis albanotella* Chamb.
- 121. *Lithocolletis obstrictella* Clem.
- 122. *Lithocolletis hageni* Frey & Boll.
- 123. *Lithocolletis argentifimbriella* Clem.
- 124. *Lithocolletis intermedia* Frey & Boll. Doubtful species.
- 125. *Lithocolletis mirifica* Frey & Boll. Doubtful species.
- 126. *Ornix quercifoliella* Chamb. Under edge of leaf turned down.
- 127. *Coriscium albanotella* Chamb. Large tentiform mine.

} Tentiform mines.

The following species either roll, fold, or sew the leaves together:

- 128. *Ypsolophus querciella* Chamb.
- 129. *Gelechia querciella* Chamb.
- 130. *Gelechia quercinigræella* Chamb.
- 131. *Gelechia quercivorella* Chamb.
- 132. *Gelechia quercifoliella* Chamb.
- 133. *Cryptolechia quercicella* Clem.
- 134. *Machimia tentorilerella* Clem. Larva in a web.

The following species feed in galls:

- 135. *Ypsolophus quercipomonella* Chamb.
- 136. *Gelechia gallægenitella* Clem.
- 137. *Hamadryas bassettella* Clem.

Coleoptera.

- 138. *Synchroa punctata* Newman. "They live in rotten oak stumps, thriving best in the white. The pupa requires about one week to perfect itself." (Horn.)
- 139. *Centronopus calcaratus* Fabr. "Inhabits black oak stumps. It remains in pupa two weeks." (Horn.)
- 140. *Centronopus anthracinus* Knoch. May be taken in company with the preceding species. (Horn.)
- 141. *Acanthoderes 4-gibbus* Say. Bores in dead twigs of oak. (Schwarz.)
- 142. *Bostrichus bicornis* Web. Under bark of white oak posts. (McBride.)
- 143. *Elaphidion atomarium* (Drury), according to Schwarz, bores in dry twigs of *Quercus virens* in Florida. (Riley.)
- 144. *Elaphidion mucronatum* Fabr., with the preceding. (Schwarz, in Riley.)
- 145. *Elaphidion parallelum* Newman. Boring in oak, etc. (Riley.)
- 146. *Tragidion fulvipenne* Say. Bores in oak. (Riley.)
- 147. *Arhopalus fulminans* Fabr. Red oak. (Fitch & Hodge.)
- 148. *Leptura zebra* Olivier. The larva and pupa inhabit the black oak. (Dr. Horn.)

149. The Dominican case-bearer, *Coscinoptera dominicana* (Fabr.), according to Riley.
 150. *Mordella 8-punctata* Fabr. Found in old oak stumps. (Riley.)

HYMENOPTERA.

List of the species of North American Cynipidæ which live on the various species of oak, by R. Osten Sacken, 1865.

LIVING ON THE WHITE AND CHESTNUT OAKS.

151. *Cynips strobilana* O. S.
 152. *Cynips globulus* Fitch.
 153. *Cynips centricola* O. S.
 154. *Cynips tubicola* O. S.
 155. *Cynips clavula* Bassett.
 156. *Cynips* (*Andricus*) *seminator* Harris.
 157. *Cynips* (*Andricus*) *petiolicola* Bassett.
 158. *Cynips* (*Andricus*) *fusiformis* O. S.
 159. *Cynips* (*Andricus*) *futilis* O. S.
 160. *Cynips* (*Andricus*) *papillata* O. S.
 161. *Cynips* (*Andricus*) *floci* Walsh.
 162. *Cynips* (*Teras*) *pezomachoides* O. S.
 163. *Cynips* (*Teras*) *forticornis* Walsh.
 164. *Cynips* (*Teras*) *hirta* Bassett.
 165. *Cynips* (*Teras*) *fulvicollis* Fitch.
 166. *Cynips* (*Teras*) *nigricollis*.
 167. *Cynips* (*Biorhiza*) *nigra* Fitch.
 168. *Cynips* nov. gen. (allied to *Spathegaster* Hartig).
 169. *Cynips irregularis* O. S.
 170. *Cynips majalis* Bassett.
 171. *Cynips batatus* Bassett.
 172. *Cynips verrucarum* O. S.

LIVING IN THE RED, BLACK, AND WILLOW OAKS.

173. *Cynips* (nov. gen.) *spongifica* O. S. (*C. aciculata* O. S., and *C. confluentis* Harris).
 174. *Cynips* (nov. gen.) *quercus-coccineæ* O. S.
 175. *Cynips* (nov. gen.) *inanis* O. S. (*C. confluentis* Fitch, not Harris).
 176. *Cynips* (nov. gen.) *coelebs* O. S.
 177. *Cynips* (nov. gen.) *ilicifoliæ* Bassett.
 178. *Cynips* (nov. gen.) *singularis* Bassett.
 179. *Cynips* (nov. gen.) *ostensackenii* Bassett.
 180. *Cynips* (nov. gen.) *formosa* Bassett.
 181. *Cynips* (nov. gen.) *sculpta* Bassett.

GROUPS WHICH WILL PERHAPS CONSTITUTE AS MANY GENERA.

The following species may belong to new genera :

182. *Q. phellos* O. S.
183. *similis* Bassett.
* * * * *
184. *Q. nigræ* O. S.
185. *tumifica* O. S.
186. *nodesta* O. S.
* * * * *
187. *operator* O. S.
* * * * *
188. *ventricosa* Bassett.
* * * * *
189. *cornigera* O. S.
* * * * *
190. *punctata* Bassett.
191. *podagræ* Walsh.
192. *scitula* Bassett.
* * * * *
193. *Q. palustris* O. S.

The following additional species of *Cynips* living on the oak have been described by Mr. H. F. Bassett. (Canadian Entomologist, Vol. XIII, p. 92.)

194. *Cynips tenuicornis*. Arizona.
195. *Cynips bella*. Arizona.
196. *Cynips minuta*. On *Quercus alba*. Connecticut.
197. *Cynips vesicula*. On *Quercus alba*. Connecticut.
198. *Cynips pattoni*. On *Quercus alba*. Connecticut.
199. *Cynips polita*. On *Quercus obtusiloba*. New Jersey, Maryland.
200. *Cynips rugosa*. On *Quercus prinoides*. Connecticut.
201. *Cynips cicatricula*. On *Quercus alba*. Connecticut.
202. *Cynips capsula*. On *Quercus bicolor*. Connecticut.
203. *Cynips affinis*. On *Quercus prinoides*. Connecticut.
204. *Cynips gemula*. On *Quercus prinoides*. Connecticut.
205. *Cynips pigra*. On *Quercus tinctoria*. Connecticut.
206. *Cynips ignota*. On *Quercus bicolor*. Connecticut.
207. *Cynips papula*. On *Quercus rubra* and *Q. tinctoria*. Connecticut.
208. *Cynips noxiosa*. On *Quercus bicolor*. Connecticut.
209. *Cynips corrugis*. On *Quercus prinoides*. Connecticut.
210. *Cynips cinerosa*. Texas.
211. *Cynips floccosa*. On *Quercus bicolor*. Ohio.
212. *Cynips coxii*. On *Quercus* sp. Arizona.
213. *Cynips suttonii* Bassett. California.
214. *Cynips batatoides* Ashmead. Live oak in Florida.

INSECTS INJURIOUS TO THE ELM.

AFFECTING THE TRUNK.

1. THE COMMON ELM-TREE BORER.

Saperda tridentata Olivier.

Order COLEOPTERA; family CERAMBYCIDÆ.

Perforating and loosening the bark and furrowing the surface of the wood with their irregular tracks, flat white longicorn borers, changing to beetles in June and July; the beetles flat, dark brown, with a longitudinal three-toothed red stripe on the outer edge of each wing-cover.

This is the most destructive borer of the elm in the Northern and Eastern States, often killing the trees by the wholesale. Great numbers of the larvæ of different sizes have been found boring in the inner bark and also furrowing with their irregular tracks the surface of the wood, the latter being, as it were, tattooed with sinuous grooves, and the tree completely girdled by them in some places. The elms on Boston Common have in former years been killed by this borer, and valuable trees, we have been informed, have been killed by them in Morristown, N. J. Fitch remarks that it consumes the inner bark of the slippery elm (*Ulmus fulva*), especially in dead and decaying trees. According to him, "the beetle deposits its eggs upon the bark in June, and the young larvæ therefrom nearly complete their growth before winter, and soon after warm weather arrives the following spring they pass into their pupa state." We have found the larvæ in abundance in the early spring in Providence in old dead elms.

The larva.—White, subcylindrical, a little flattened, with the lateral fold of the body rather prominent; end of the body flattened, obtuse, and nearly as wide at the end as at the first abdominal ring. The head is one-half as wide as the prothoracic ring, being rather large. The prothoracic segment, or that next to the head, is transversely oblong, being about twice as broad as long; there is a pale dorsal corneous transversely oblong shield, being about two-thirds as long as wide, and nearly as long as the four succeeding segments; this plate is smooth, except on the posterior half, which is rough, with the front edge irregular and not extending far down the sides. Fine hairs arise from the front edge and side of the plate, and similar hairs are scattered over the body and especially around the end. On the upper side of each segment is a transversely oblong ovate roughened area, with the front edge slightly convex, and behind slightly arcuate. On the under side of each segment are similar rough horny plates, but arcuate in front, with the hinder edge straight.

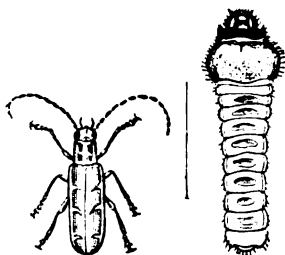


FIG. 17.—Larva (from life) and adult of the elm-tree borer.—From Packard.

It differs from the larva of *Saperda vestita* Say in the shorter body, which is broader, more hairy, with the tip of the abdomen flatter and more hairy. The prothoracic segment is broader and flatter, and the rough portion of the dorsal plates is larger and less transversely ovate. The structure of the head shows that its generic distinctness

from *Saperda*, originally insisted on by Mulsant, may be well founded, as the head is smaller and flatter, the clypeus being twice as large, and the labrum broad and short, while in *Saperda vestita* it is longer than broad. The mandibles are much longer and slenderer, and the antennæ are much smaller than in *Saperda vestita*.

The beetle is a rather flat-bodied, dark-brown beetle, with a rusty-red curved line behind the eyes, two stripes on the thorax, and with a long red stripe on the outer edge of each wing-cover, with three long points projecting inwards; 0.50 inch in length.

2. THE LATERAL SAPERDA-BORER.

Saperda lateralis Fabricius.

Order COLEOPTERA; family CERAMBYCIDÆ.

Mining the inner bark of dead trees and logs of the common elm, a grub very similar to the foregoing, and about the 1st of June producing a similar beetle, but differing in wanting the transverse teeth or points arising from the marginal stripe on the wing-covers. (Fitch.)

3. THE SIX-BANDED DRYOBIUS.

Dryobius sex-fasciatus Say.

Order COLEOPTERA; family CERAMBYCIDÆ.

A similar but larger grub than that of *Saperda tridentata*, but found with it, producing a black beetle of nearly similar form, with the edge of the thorax yellow, and also its scutel, with four yellow equidistant oblique bands on its wing-covers, the last one situated at the tip. Length 0.70 inch. (Fitch.) It also occurs on the beech according to C. G. Siemens.

4. THE ELM BARK-BORER.

Tomicus (Phloeotribus) liminaris Harris.

Order COLEOPTERA; family SCOLYTIDÆ.

Making small perforations like pinholes, appearing in the bark, especially of diseased elms, from which, in August and September, issues a minute cylindrical bark-beetle of a dark-brown color; its wing-covers with deeply impressed punctured furrows and short hairs; its thorax also punctured. Length 0.10 or less. (Harris.)

5. THE DARK ELM BARK-BORER.

Hylesinus opaculus Leconte.

Living under the dry bark of the elm and ash trees, a stout pitchy-black timber beetle. (Riley.)

The beetle.—Stout, opaque, when mature of a uniform piceous-black color. Head punctulate, not narrow in front, without transverse impressions in front of the eyes. Epistoma (Fig. 18, *b*) truncate or very slightly and broadly emarginate. Labrum visible. Antennal club very large, oblong-oval, the first two joints shining and pubescent only at apex. Thorax wider than long, very densely punctate; pubescence moderately thick and short. Elytral striæ (Fig. 18, *d*) evidently impressed and regularly, coarsely punctate; interstices very distinct, each with a regular row of small tubercles, which become more acute toward the apex and the sides. Pubescence very coarse and short. Tibiæ (Fig. 18, *e*) hardly dentate. (Riley's Rep. Ent. Dep. Ag. 1879, p. 45. The other figures illustrate *H. trifolii*.)

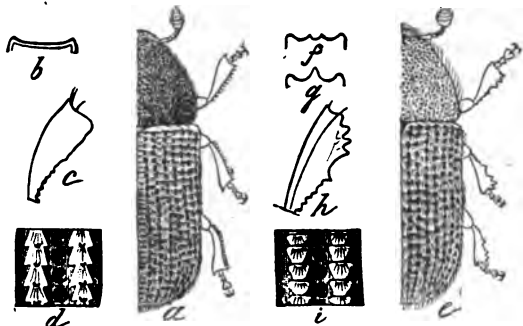


FIG. 18.—The dark elm bark-borer.—After Riley.

1879, p. 45. The other figures illustrate *H. trifolii*.)

6. THE SHORT-LINED DULARIUS.

Dularius brevilineus Say.

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in partly dead or dry elms, the larva of a pretty longicorn, with deep purplish-blue wing-covers with three short white lines in the middle.

This beetle was first bred from the dry wood of the elm by Riley, the larvæ occurring in Ohio. It was also known, by the late Mr. G. D. Smith, to inhabit this tree, probably in the vicinity of Boston; it was



FIG. 19.—Elm-tree borer—From Packard.

noticed in our 2d Mass. Report, p. 18. Mr. George Hunt has observed this beetle on the bark of an elm at Plymouth, N. H., in the middle of July, inserting its eggs in the crevices of the bark. It is a singular-looking beetle, with a round, flattened prothorax, and wing-covers contracted in the middle, and not covering the tip of the abdomen, while the thighs are unusually swollen. The antennæ are about two-thirds the length of the body, flattened towards the end, and somewhat serrate. The body

above is velvety black, and brown-black beneath. The head is black and coarsely punctured, and the prothorax is covered with short, dense, black hairs, like velvet. The wing-covers are Prussian blue in color, bent, corrugated, with an interrupted ridge just outside of the middle of each cover. They are covered with fine, black hairs, bent over. There is a pair of parallel, short honey-yellow lines in the middle of each wing-cover, with a third one a little in front, making in all six streaks. The legs and feet are black. It is a little over eight-tenths of an inch in length.

6. *Neoclytus erythrocephalus* Fabricius.

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in dead elms in Michigan (Hubbard); also raised from hickory-wood (Horn).

7. THE TREE CRICKET.

Æcanthus niveus Serville.

Order ORTHOPTERA; family GRILLIDÆ.

Boring into the corky bark of the elm in the Southern States, inserting its eggs irregularly, not in regular series as when it oviposits in the stems of the blackberry, raspberry, grape, &c.; a slender pale-green cricket, with white wings and a large ovipositor; the males shrilling loudly.

The eggs of the tree cricket begin to develop as soon as they are laid in the early autumn, and the embryo partially develops, so that the rudimentary limbs may be seen, as well as the mouthparts; the insect completes its development in the early part of the following summer, appearing early in August.



FIG. 20.—Male tree-cricket.—After Harris.



FIG. 21.—Female tree-cricket, natural size.—After Harris.

AFFECTING THE LEAVES.

8. THE CANKER WORM.

Anisopteryx vernata Peck.

Order LEPIDOPTERA; family PHALENIDÆ.

Very injurious to the elm in the Eastern States, stripping the trees; a dark-striped measuring worm varying in color to pale green, transforming from the middle to the last of June in the earth to a pupa, some appearing in the autumn but most abundantly in March; the female grub-like, the male winged.

Originally confined, as an injurious insect, to New England, it is now destructive in the Western States (Illinois and Missouri), and must originally have occurred all over the United States east of the Mississippi, as I have received it from Texas.



FIG. 22.—Canker worm: b, egg; c, side; d, back of a segment.—After Riley.



FIG. 23.—a female canker-worm moth; b, male; c, antennæ joints of female; d, one of female abdominal segments; e, ovipositor.—After Riley.

About the 1st of May, at the time when the leaves of the apple are unfolding, the young canker worms break through the eggs, which have been laid earlier in the season, in March and April, in patches on the bark of the trunk and limbs. They may be soon found clustering on the terminal buds and partly unfolded leaves, and are then about a line in length, and not much thicker than a bit of thick thread. Fortunately, owing to the want of wings, the female is exceedingly sedentary, and year after year the apple and elm trees of particular orchards and towns are defoliated and turned brown, while adjoining orchards and towns scarcely suffer. By the 20th of June, in Essex County, Massachusetts, the orchards or shades elms infested by them look as if a fire had run through them. At that date the worms are fully fed, and they then descend to the ground, letting themselves down by a silken thread. At this time I have destroyed thousands by jarring the tree and collecting those which fall down. I have watched old and young robins busily

engaged in eating them, and from the number of toads in my garden, gathered under the trees, I feel confident that they eat multitudes of them.

The worms at once enter the ground, change to chrysalids several inches below the surface, near the trunk of the tree, and there remain until the early days of March and April, when the wingless females ascend the trees, and the winged males may be seen fluttering about.

I took pains one spring, in the middle of April, to count the number of these moths on my apple trees, fourteen in number, averaging from six to seven inches in thickness, besides three elms. They were more abundant on the apple trees than on the elms. But on those seventeen trees there were counted, adhering mostly to the tarred paper, one thousand males and two hundred females. The spring of 1875 was cold and backward, and few moths were seen before this date. From these data we can ascertain approximately the relative numerical proportions between the sexes, which seems to approximate five males to one female.

The species I have referred to is the spring moth, the *Anisopteryx vernata* of Peck, but not of Harris. *A. autumnata* is much less abundant in the adult condition, and only appears in the autumn. The wings are thicker than those of *vernata*, and the caterpillar has an additional pair of prop-legs, though so short as to be useless. I find that most of the damage is done by the caterpillars of *vernata*. On June 15, 1875, I collected five hundred and fifty-seven caterpillars from the apple trees in my garden. Of these, five hundred and twenty were *vernata*, and twenty-seven were the young of the autumn species. Peck, in his account published in 1795, states that *vernata* does the principal damage.

Remedies.—The use of printer's ink laid on tarred paper is the cheapest, though the ink should be applied every day or two. The use of tin troughs of oil surrounding the tree is almost sure to stop the ascent of the females, while wooden troughs of oil built around the bottom of the trunk is almost equally efficacious. Care and attention, and, above all, co-operation among those suffering from these worms will enable us to check their ravages.

9. UNKNOWN MEASURING WORM.

Feeding on the leaves May 30 and June 1, at Providence, a reddish-green obscurely striped larva, much like the canker worm in form and size, but a little stouter.

10. THE ELM SPAN-WORM.

Eugonia subsignaria (Hübner).

Order LEPIDOPTERA; family PHALENIDÆ.

Hatching from the eggs as soon as the leaves unfold and living unobserved for a week or two on young shoots in the tree tops, measuring or span worms, resembling the twigs of the elm in color, with a large red head, and the terminal ring of the body

bright red; pupating towards the end of June, and during July and August transforming into a snow-white moth.

This insect is widely spread. I have observed it in the forests of Northern Maine in August, and it is common in the Middle States. It is very destructive to the elms in New York City and Philadelphia, though not known to be destructive in the country. The moth may at once be recognized by the snow-white body and wings, the anterior pair being angular and the hinder pair slightly notched. It is, according to Fitch, still more destructive to the linden than to the elm.



FIG. 24.—Elm span-worm moth, natural size.—After Packard.

11. THE NOVEMBER MOTH.

Epirrita dilutata (Hübner).

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding on the leaves in spring; a dirty-green measure-worm, beneath paler bluish white, its breathing pores forming a row of orange-red dots along each side, where is sometimes also a yellow line; entering the ground in summer, the moth appearing in November. (Fitch.)

In our monograph of the *Phalœnidæ* we had overlooked the fact that Fitch had observed this moth in New York, flying slowly in forests in November. It appears to be more abundant in subarctic regions than in New England, as we have received numerous specimens of it from Newfoundland, and it has also been obtained in Labrador. It is probable that it will rarely occur in injurious numbers on elm trees in New England. In Europe, according to Newman, "it feeds on white-thorn, black-thorn, horn-beam, sloe, oak, and almost every forest tree, and is full-fed in June." Our species in British America, probably like *E. cambricaria*, will be found feeding on the mountain ash, a common tree in Labrador and Newfoundland.

The moth.—A much larger species than *E. cambricaria*, which is more common, and which also occurs in Northern Europe. It may always be distinguished from the other species of the genus by the simple not pectinated male antennæ. The body and wings are pale ash-gray; fore wings with eight well-defined sinuous or scalloped blackish lines, most distinct on the costa and veins; the basal line is heavy, and bent rectangularly between the subcostal and median veins; the next line, rather remote from the basal, curves inward on the subcostal vein, and outward on the median space; the two lines beyond are approximate, but less sinuous; the fourth line from the base of the wings is broad, diffuse, twice as broad on the costa as the three others; beyond this line is a clear median space, in the middle of which is the distinct discal dot; beyond are four more or less distinct lines, of which the outer (or submarginale) is most distinct and regularly scalloped; a marginal row of twin black dots; fring. whitish. Hind wings with traces of four scalloped lines, the marginal one the heaviest. Expanse of wings, 1.60 inches.

12. THE ELM GALERUCA.

Galeruca californiensis (Linnaeus).

Order COLEOPTERA ; family CHRYSOMELIDÆ.

Thick, cylindrical, blackish, six-footed grubs, often wholly defoliating the trees, and changing into an oblong oval beetle a quarter of an inch long, of a grayish yellow color, with three small black spots on the prothorax, a broad black stripe on the outer edge of its wing-covers, and a small oblong spot near their base. (Fitch.)

13. THE LADDER CHRYSOMELA.

Chrysomela scalaris (Le Conte).

Order COLEOPTERA ; family CHRYSOMELIDÆ.

Feeding on the leaves throughout the season, a shining, hemispherical, bottle-green beetle, with silvery-white wing-covers, on which are several bottle-green spots, and a broad jagged stripe on their suture ; its wings rose-red and its antennæ and legs rusty yellow. Length, 0.30 to 0.40. More common on willows, and especially the alder. The larva is thick and fleshy, with a row of black spiracles along the side of the body and a dark prothoracic shield.

14. THE AMERICAN CIMBEX SAW-FLY.

Cimber americana (Leach).

Order HYMENOPTERA ; family Tenthredinidæ.

A cylindrical, glaucous, yellowish-white worm, coiled and marked like a snail's shell, having a broad black line along the back ; when disturbed ejecting a watery fluid from pores situated above the spiracles ; transforming into the largest species of saw-fly we have, with stoutly-knobbed antennæ ; appearing early in summer. It also feeds on the birch, linden, and willow.

15. THE ANTIOPA BUTTERFLY.

Vanessa antiopa (Linnaeus).

Order LEPIDOPTERA ; family PAPILIONIDÆ.

Sometimes occurring on the elm, but more common on the willow ; a stoutly-spined caterpillar, with a black body spotted minutely with white, with a row of eight dark brick-red spots on the back ; changing to a dark brown chrysalis, with large tawny spots around the tubercles on the back. The butterfly purplish brown above, with a broad buff-yellow border in which is a row of pale blue spots. Flying from March till June, and again from the middle of August until late autumn.

16. THE GREAT ELM-LEAF BEETLE.

Monoclea coryli (Say).

Order COLEOPTERA ; family CHRYSOMELIDÆ.

Occasionally destructive to the red or slippery elm in the Middle States ; a pale yellowish beetle more than half an inch long, with the wing-covers twice spotted with blue ; laying its yellow eggs in a cluster on the under side of the leaf in June, the grub appearing a week later, being brown or yellowish brown, and eating the leaves

into rags; towards the end of July or early in August entering the ground, forming an oval cavity a few inches below the surface; assuming the pupa state a week before they appear as beetles in June. (Riley.)



FIG. 25.—The great elm-leaf beetle. a, b, eggs; d, larva; g, h, head and mouth parts of the same; i, pupa; j, beetle.—After Riley.*

15. THE INTERROGATION BUTTERFLY.

Grapta interrogationis (Fabricius).

Injuring the foliage of the elm as well as linden tree and hop-vine, a caterpillar, with reddish black, bilobed head, and black body covered thickly with streaks and dots

*This and several other cuts have been loaned by the permission of the Hon. George B. Loring, Commissioner of Agriculture.

of yellowish white, transforming into our largest species of *Grapta*, and marked on the under side of the dull hind wings with a golden semicolon.

The larva is an inch and a quarter long. The head is reddish black, flat in front and somewhat bilobed, each lobe tipped with a tubercle emitting five single black pointed



FIG. 26. *Grapta progne*.—From Packard.

spines. It is covered with many small white and several blackish tubercles. The body is cylindrical, black, thickly covered with streaks and dots of yellowish white; the second segment is without spines, but with a row of yellowish tubercles in their place; the third segment has four branching spines, all black, with a spot of dark yellow at their base; and on the fourth segment are four spines, as there are on all the others, excepting the terminal, which has two pairs, one posterior to the other.

The spines are yellow, with blackish branches, excepting the terminal pair, which is black; and there is a row of reddish ones on each side. The under surface is yellowish gray, darker on the anterior segments, with a central line of blackish, and many small, black dots. (Saunders.)

The chrysalis is ash brown, with the head deeply notched; and there are eight silvery spots on the back. The chrysalis state lasts from twelve to fourteen days.

16. THE SILVER-C GRAPTA.

Grapta progne (Cramer).

Late in June, eating the leaves, a more common spiny caterpillar than the preceding, being white mottled with gray, the butterfly smaller than the foregoing and marked with a reversed silver c or comma in the middle of the hinder wings; but one brood of butterflies appearing in July.

The larva is gray, mottled with whitish; head white, with two black prickles. The two upper long-branched prickles upon the second ring black; no spines on the prothoracic segments; those on the succeeding rings white, tipped with black; their branches white, toward the forward end of the body becoming more and more tipped with black. (Fitch.)

17. THE COMMA BUTTERFLY.

Grapta comma (Harris).

Another caterpillar closely resembling that of *G. progne*, but differing in being of a brownish-red color in front and white or pale yellow behind.

The half-grown larva is black, with a yellowish stripe along the side from the third segment to the tail, and with yellow stripes across the back, and spots of the same color at the base of the dorsal spines, which are yellow, tipped with black. The mature caterpillar is white, mottled or striped with gray or ashen, and with red spiracles (W. H. Edwards). It differs from the larva of *G. progne* in its brownish-red face, and in being more yellowish on the abdominal segments.

The chrysalis is brownish-gray or white, variegated with pale brown and ornamented with gold on the tubercles.

The butterfly differs from the *Progne* in the hind wings having a black spot on their center, as well as two others toward their base, and on their under sides a central silvery curved mark like the letter c. Expanse of wings about two inches. It appears in May, and a second brood in July, August, and September. This caterpillar is more common on the currant and hop.

18. THE FOUR-HORNED SPHINX CATERPILLAR.

Ceratonia quadricornis (Harris).

Order LEPIDOPTERA; family SPHINGIDÆ.

Occasionally eating the leaves, a stout green worm with a large horn on its tail and four shorter horns just behind the head, and seven oblique white lines on each side of the body.

This worm not unusually occurs from Maine southward on the elm, becoming fully fed early in September, when it descends into the ground and pupates, the moth appearing the following May and June. I have taken it in Maine as early as May 24. The moth is a large broad-winged sphinx, with gray or ashen body and wings, the anterior pair with a large white dot near the front edge.

19. THE FALL WEB WORM.

Hyphantria textor (Harris).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Disfiguring in August and early in September the branches of the elm with their unsightly webs in which they live socially; slender, greenish-yellow caterpillars, dotted with black, with rather sparse, silken, whitish hairs, and transforming into a pure white moth.

The fall web worm should not be confounded with the American tent caterpillar, being about half the size of the latter, and appearing late in summer, when the tent caterpillar has disappeared. It is abundant and unwearying in its attacks on different fruit and shade trees. It is omnivorous in its taste and one of the most abundant pests in the Southern as well as Northern States, being abundant in Maine, and ranks with the canker-worm as a general nuisance. The webs can be removed by hand or by the use of mops dipped in a solution of carbolic acid or kerosene oil; or the branch with the web may be cut off. It occurs on fruit trees, as well as the hickory, black walnut, and sometimes the oak.

The larva when young is pale yellow, with the hairs quite sparse, and with two rows of black marks along the body; the head is black.

When fully grown it is pale yellowish or greenish, with a broad dusky stripe along the back and a yellow stripe along the sides. It is hairy, the rather long whitish hairs springing from black and orange-yellow warts. It is very variable as to depth of coloring and markings.

The moth is stout-bodied and entirely white. The female deposits her eggs in a cluster on a leaf generally near the end of a branch, the eggs hatching during the months of June, July, and August, earlier or later, according to the latitude. Each worm begins spinning the moment it is born, and by their united effort they soon cover the leaf with a web, under which they feed in company, devouring only the pulpy parts of the leaf. (Riley.)

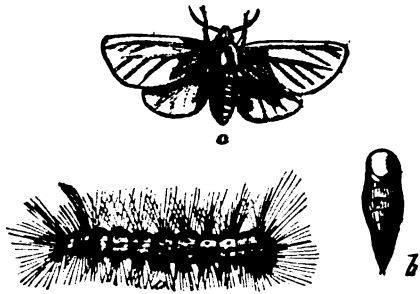


FIG. 27.—Fall web worm (a); b, pupa (a very poor figure); c, imago.—After Riley.

20. THE ELM GALL-LOUSE.

Colopha ulmicola (Fitch).

Order HEMIPTERA; family APHIDÆ.

Making in June a large excrescence like a cock's comb on the upper side of the leaf, the gall about an inch long and a quarter of an inch high, compressed, and its sides wrinkled perpendicularly, with its summit irregularly gashed and toothed, of a paler green color than the leaf and more or less red on the side exposed to the sun; opening on the under side of the leaf by a long slit-like orifice; inside wrinkled perpendicularly into deep plaits and occupied by one female and a number of her young, which are minute oval yellowish white lice 0.02 inch long, with blackish legs; the female more or less coated with white meal on her back, 0.07 long, oval and pale yellow, with blackish legs and antennæ. By midsummer the galls dry up. (Fitch.)

21. THE WOOLY ELM-TREE LOUSE.

Eriosoma Rileyi (Thomas).

Order HEMIPTERA; family APHIDÆ.

Clustering on the limbs and trunks of the white elm, causing a knotty unnatural growth of the wood, small aphides covered with an intense white wool-like substance, the limbs at a distance appearing like snow. (Riley.)

In Illinois and Missouri, late in May and in June, the white elms in the larger cities are apt to become infested with these conspicuous and curious insects. Riley finds that by washing with a weak solution of cresylic acid soap they will be instantly killed.

The adult is dark blue, the wings clear, three times as long as wide, and more pointed at the ends than in *E. pyri*. Costal and subcostal veins, and that bounding the stigma behind robust and black. Length to tip of closed wings, exclusive of antennæ, 0.12 inch.

The young lice are narrower and usually lighter colored than the adults, varying from flesh to various shades of blue and purple. (Riley.)

The following insects also prey on the elm :

HEMIPTERA.

22. Common elm aphid. *Schizoneura americana* (Riley).23. Yellow elm louse. *Callipterus ulmicola* Thomas. (VIII, 111).

COLEOPTERA.

24. The grape-vine flea beetle. *Graptodera chalybea* Illiger.25. The goldsmith beetle. *Cotalpa lanigera* (Linn.).26. *Magdalis armicollis* Say. (Inhabits the elm, Lebaron., 4th Rep).

LEPIDOPTERA.

27. *Anthaxia viridicornis* Say. (Psyche II, 40.)28. *Synchroa punctata* Newman. (Psyche II, 40.)28. The American silk worm, *Telea polyphemus* Hübner.29. The Emperor moth, *Hyperchiria io* (Fabricius).

31. The vaporor-moth caterpillar, *Orgyia leucostigma* Sm.-Abb.
32. *Tolyte velleda* (Stoll).
33. *Acronycta ulmi* Harris. (Corr. 312.)
34. *Paraphia unipunctaria* (Haworth).
35. *Metanema quercivoraria* Guenée.
36. *Nephopteryx undulatella* Clemens.
37. *Nephopteryx? ulmi-arrosorella* Clemens.
38. *Bactra? argutana* Cl. (also on sumach, witch-hazel, and black-thorn).
39. *Lithocolletis argentinetella* Clem. Larva makes a tentiform mine in the under side of the leaves; rarely in the upper side. (Chambers.)
40. *Lithocolletis ulmella* Chamb. Larva makes a flat mine in the upper side of the leaf. (Chambers.)
41. *Argyresthia austerella* Zeller. This moth, "I am convinced, feeds in some way on it; and in latter May and in June the imago may be found about the trees." (Chambers.)

HYMENOPTERA.

42. The horn-tail borer, *Tremex columba* (Linn.).
43. Elm saw-fly, *Cimbex americana* var. *Cimbex laportei*.

INSECTS INJURIOUS TO THE HICKORY.

(Carya alba and tomentosa.)

INJURING THE TRUNK AND BRANCHES.

1. THE COMMON HICKORY BORER.

Goes tigrinus (De Geer).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring large holes lengthwise in the solid wood, a cream-colored grub, with the first segment behind the head flattened, pale tawny-yellowish, changing to a pupa in its burrow, and in summer appearing as a long-horned brown beetle an inch long, covered with a close gray pubescence, the wing-covers with a broad dark brown band beyond their middle and another on their base, the thorax with an erect blunt spine on each side; the antennæ pale yellowish, with their first joint dark brown. (Fitch.)

This is perhaps the most common borer in the hickory and walnut in the Northern States. According to Fitch the young worm lives at first upon the soft outer layers of the sap-wood, mining a shallow cavity all around the orifice in the bark, and the bark dies and turns black as far as this burrow extends. Its jaws having at length become sufficiently strong, it gnaws its way into the solid wood from the upper part of its burrow under the bark, boring obliquely inward and upward, all the lower part of its burrow being commonly packed with its sawdust-like chips. Finally, having completed its growth, it extends the upper end of its burrow outward again to the bark.

2. THE BEAUTIFUL HICKORY BORER.

Goes pulcher (Haldeman).

Similar to the preceding. "Scarce, but a few are found every season in the shag-bark and pignut hickory, June and July." (Dr. T. Hodge, Buffalo, N. Y., Amer. Ent., iii, p. 270.)

3. THE BELTED CHION.

Chion cinctus (Drury).

Order COLEOPTERA; family CERAMBYCIDÆ.



FIG. 29.—The belted Chion.

A worm like the preceding and with similar habits, forming long galleries in the trunk in the direction of the fibers of the wood, producing a more flattened long-horned beetle from two-thirds to a little over an inch long, of a hazel-brown color, with a short dull straw-yellow band placed obliquely forward of the middle of each wing-cover, and with a small sharp spine on each side of the prothorax, and two slender ones on the tips of each wing-cover; the antennæ of the males more than twice the length of the body. (Harris.)

4. THE DISCOIDAL SAPERDA.

Saperda discoides (Fabricius).

Order COLEOPTERA; family CERAMBYCIDÆ.

A similar but much smaller worm than the foregoing, changing to a cylindrical long-horned beetle of a black or blackish-brown color, clothed with ash-gray pubescence which is less dense above and commonly forms three gray stripes upon the thorax, and a band or crescent upon the middle of the wing-covers, its legs yellow or reddish. Length 0.40 to 0.60 inch. (Fitch.)

5. THE COMMON HICKORY BORER.

Cyllene picta Drury.

Boring in the trunk of the hickory, a whitish worm, one-half an inch long, the beetle appearing in June. (See Locust-tree borer.)

We have received this insect in all its stages from Mr. H. Gillman, of Detroit, who several years ago found several of them in a hickory log March 10th. From these living specimens the following description was drawn up:

Larva.—Body thick; mouth-parts black; head reddish behind the antennæ. Prothoracic segment (first behind the head) large and broad, being one-half as long as broad; flat and broad above, the upper surface being lower than that of the succeeding segment; the anterior edge thickened, being slightly corneous; a mesial deeply impressed line, especially on the hinder two-thirds, where it becomes a broad, deep angular furrow, dividing the tergum into two quadrant-shaped halves; the outer edge of the segment rises above the flattened tergal portion, which is sparsely covered with hairs; the latter thicker along the sides of the body. The body contracts in width behind the 4th abdominal segment; the upper side of each of the first six abdominal segments (corresponding to those segments in the beetle) is raised into blister-like swellings, especially on the 5th and 6th segments, which are much narrower than the four preceding segments. These dorsal swellings are smooth and free from fine hairs. Abdominal segments 7-9 convex above, not swollen, and the abdomen is narrowest between the 5th and 6th segments. A pair of large spiracles on the mesothoracic segment, and a pair on each of the first eight abdominal segments.

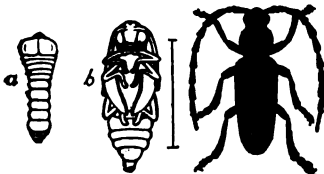


FIG. 30.—Common hickory borer; male, nat. size; a, larva; b, pupa.—From Packard.

Antennæ 3-jointed; the two basal joints being of the same length; the basal one being one-third stouter than the 2d; the 3d joint filiform, and one-half as long as the

2d joint, and ending in two or three hairs. The thin membranous labrum is divided into two parts, the basal solid, the terminal portion forming a moveable flap, overlapping and reaching nearly to the end of the mandibles when closed; the basal portion is shorter than broad, being broadly trapezoidal and smooth; the outer division is



FIG. 31.—Larva injurious to hickory insects.

broader than long, the edges being rounded, so that it is almost broadly ovate (transversely) and smooth, covered with long hairs. It is pale membranous, of a testaceous hue. Mandibles black, very thick and stout, with obtuse, rounded edges; they are almost as long as the base is broad. Maxillæ membranous, flattened; maxillary palpi 2-jointed. Labium membranous, with a transverse chitinous band near the insertion of the 2-jointed palpi; both joints short; second one-half as thick as the first; edge hairy, the hairs reaching to the ends of the palpi. Length of body 0.50 inch; breadth of prothoracic segment, 4.2^{mm}; breadth of head, 3.2^{mm}.

Fig. 31 represents a larva which probably preys on the young of this and other hickory insects, as it is not uncommon under the bark of the hickory in Massachusetts. It belongs to the family *Nitidulidæ*.

6. THE HICKORY TWIG GIRDLER.

Oncideres cingulatus (Say).

Order COLEOPTERA; family CERAMBYCIDÆ.

Girdling and occasionally cutting off the twigs and branches, a thick-bodied, longicorn, dark gray beetle 0.60^{inch} long, with its wing-covers sprinkled over with faint tawny yellow dots.

This singular beetle, which inhabits the Eastern United States, appears in Pennsylvania from the middle of August until the middle of September. Fig. 32 represents the beetle and the incision it makes, and Fig. 33, from a drawing sent us by the late Prof. Haldeman, shows how

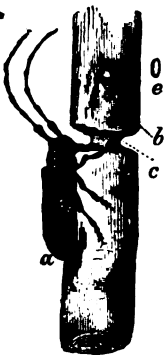


FIG. 32.—Hickory twig girdler.—After Riley.

the beetle may injure several adjoining twigs. The editors of the *American Entomologist* (I, p. 76) state that they have counted in a persimmon branch not more than two feet long, as many as eight eggs, placed one

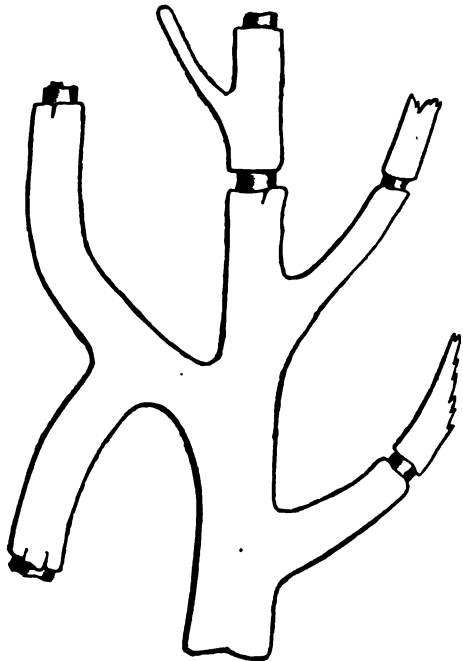


FIG. 33.—Tree cut by the twig girdler.—From Hayden's Report.

under each successive side-shoot, while they have found seven eggs all crowded together in a small hickory branch only three inches long. Prof.

Haldeman states that "both sexes are rather rare, particularly the male, which is rather smaller than the female, but with longer antennæ. The female makes perforations (Fig. 32, b) in the branches of the tree upon which she lives, which are from half an inch to a quarter of an inch thick, in which she deposits her eggs (one of which is represented of the natural size at Fig. 32, e). She then proceeds to gnaw a groove, of about a tenth of an inch wide and deep, around the branch and below the place where the eggs are deposited, so that the exterior portion dies and the larva feeds upon the dead wood." In the case noticed by Prof. Haldeman, the tree attacked was the shag-bark hickory (*Carya alba*) and the incisions were so shallow as not to break off until after the larva had matured within it, or nearly a year after the girdling. But in most of the cases observed by Messrs. Walsh and Riley upon pear and persimmon trees, "the twig was girdled so deeply that it broke off and fell to the ground with the first wind, and while the eggs that had been laid in it by the mother-beetle were still unhatched. Even in a girdled hickory twig 0.35 inch in diameter, which we have now lying before us, but a third part of its diameter is left in the middle ungnawed away, so that in spite of the superior toughness of this timber the twig could scarcely have stood a high wind without breaking off and falling to the ground."

7. THE SLENDER-FOOTED DYSPHAGA.

Dysphaga tenuipes (Haldeman).

A small grub, in the dead limb and twigs, producing in May a small black longicorn beetle with rough wing-covers but half as long as the abdomen and tinged with paler yellowish at their bases, its head having a furrow in the middle and its thorax cylindrical. Length 0.25 inch. (Fitch).

8. THE LURID DICERCA.

Dicerca lurida (Fabricius).

Order COLEOPTERA; family BUPRESTIDÆ.

Boring in the trunks and limbs of the pig-nut hickory, a flat-headed grub of a yellowish-white color, changing to a flattened, hard-shelled beetle with short slender antennæ, of a lurid dull brassy color above, and bright copper beneath, with the wing-covers lengthened into diverging obtuse points.

The larva is of a yellowish-white color, very long, narrow, and depressed in form, but abruptly widened near the anterior extremity. The head is brownish, small, and sunk in the fore part of the first segment; the upper jaws are provided with three teeth, and are of a black color; and the antennæ are very short. The segment which receives the head is short and transverse; next to it is a large oval segment, broader than long, and depressed or flattened above and beneath. Behind this, the segments are very much narrowed and become gradually longer; but are still flattened, to the last, which is terminated by a rounded tubercle or wart. There are no legs, nor any apparatus which can serve as such, except two small warts on the under side of the second segment from the thorax. (Harris.)

The beetle is of a lurid or dull brassy color above, bright copper beneath, and thickly punctured all over; there are numerous irregular impressed lines, and several narrow elevated black spots on the wing-covers, the tips of each of which ends with two little points. Length 0.60-0.80 inch.

9. *Stenosphenus nolatus* (Olivier).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in the hickory tree, a specimen having been cut from a hickory tree in March. (C. V. Riley, Amer. Ent., vol. iii, p. 239.)

10. *Neoclytus erythrocephalus* (Fabricius).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in hickory wood; nothing farther known regarding its habits.

This beetle has been raised from hickory wood by Dr. G. H. Horn. (Proceedings of the Entomological Society of Philadelphia, vol. 1, p. 29.) It has also been found boring in a dead elm by Mr. H. G. Hubbard, of Detroit, Mich., and a gravid female was found near the root of a rose-bush in Washington, D. C. (Riley).

11. *Dorcaschema nigrum* (Say).

Order COLEOPTERA; family CERAMBYCIDÆ.

Bores in the hickory, according to Dr. F. Hodge, Buffalo, N. Y.

12. THE HICKORY BARK-BORER.

Scolytus 4-spinosus (Say.)

Order COLEOPTERA; family SCOLYTIDÆ.

Undermining the bark and making long slender tracks radiating from a primary larger vertical chamber; a white footless grub, becoming a small cylindrical weevil-like beetle.

This very destructive bark-borer affects the bitter-nut, shell-bark, pig-nut hickory and probably the pecan (*Carya olivæformis*). According to Riley the beetle issues the latter part of June and early part of July. "Both sexes bore into the tree—the male for food, and the female mostly for the purpose of laying her eggs. In thus entering the tree they bore slantingly and upward, and do not confine themselves to the trunk, but penetrate the small branches and even the twigs. The entrance to the twig is usually made at the axil of a bud or leaf, and the channel often causes the leaf to wither and drop or the twig to die or break off.

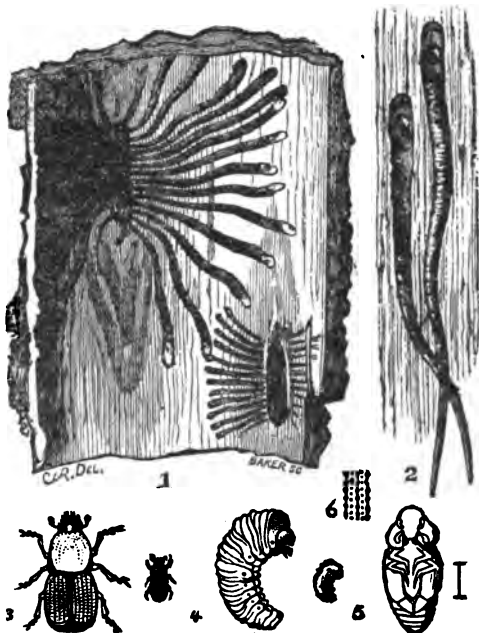


FIG. 34.—Hickory bark-borer. 1, 2, its "mine"; 3, the beetle; 4, larva; 5, pupa.—After Riley.

"The female, in depositing, confines herself to the trunk or larger limbs, placing her eggs each side of a vertical chamber, as described by

Mr. Bryant.* Here she frequently dies, and her remains may be found long after her progeny have commenced working. The larvæ bore their cylindrical channels, at first, transversely and diverging (Fig. 34, 1), but afterwards lengthwise along the bark (Fig. 34, 2), always crowding the widening burrows with their powdery excrement, which is of the same color as the bark. The full-grown larva (Fig. 34, 4, natural size and enlarged) is soft, yellowish and without traces of legs. The head is slightly darker, with brown jaws, and the stigmata so pale that they are with difficulty discerned. It remains torpid in the winter, and transforms to the pupa state about the end of the following May. The pupa (Fig. 34, 5) is smooth and unarmed, and shows no sexual differences. The perfect beetle issues through a hole made direct from the sap-wood, and a badly infested tree looks as though it had been peppered with No. 8 shot. The sexes differ widely from each other, the male having spines on the truncated portion of the abdomen, not possessed by the female. The eggs are deposited during the months of August and September, and the transformations are effected within one year, as no larvæ will be found remaining in the tree the latter part of July.

Two ichneumon parasites, according to Riley, prey upon this insect, and after killing the grub spin little pale cocoons. They are *Spathius trifasciatus* Riley, and *Bracon scolytivorus* Cresson.

The beetle.—Male entirely black, or black with brown wing-covers; the head above flat, concave towards tip; thorax very little longer than wide, and narrowing in front but slightly. Elytra with about 10 striæ confused at the sides, but regular above, and composed of small, deep, approximate punctures; interstitial spaces with a single row of minute and nearly obsolete punctures. The female differs in having the head rather shorter, more rounded, less hairy, and the venter unarmed. Length 0.15–0.20 inch. (Riley.)

13. *Sinoxylon basillare* (Say).

Order COLEOPTERA; family PTINIDÆ.

Inhabits hickory wood, in which it bores to a considerable depth, preferring the hard central wood. Its borings are very fine, and firmly compressed. After full development is attained it makes its way out almost at a right angle and emerges through a circular opening in the bark of the hickory. (Horn.)

14. RED-SHOULDERED APATE.

Apate basilaris (Say).

Order COLEOPTERA; family SCOLYTIDÆ.

Boring deep, small, straight holes to the heart of the tree, which is entirely killed by this insect, and transforming at the bottom of the hole.

The beetle is deep black and punctured all over; thorax very convex and rough in front; the wing-covers not excavated at the tip, but sloping downward very sud-

* The mode of operation appears to be as follows: Boring through the bark, the insect forms a vertical chamber next to the wood, from half an inch to an inch in length, on each side of which it deposits its eggs, varying in number from twenty to forty or fifty in all. The larvæ, when hatched, feed on the inner bark, each one following a separate track, which is marked distinctly on the wood. Some trees contain them in such numbers that the bark is almost entirely separated from the wood. In many cases the upper part of the tree is killed a year or two before the lower part is attacked. (Riley's Fifth Annual Report Inj. Ins. Missouri, p. 104.)

denly behind, as if obliquely cut off, the outer edge of the cut portion armed with three little teeth on each wing-cover, and on the base or shoulders a large red spot 0.20 inch in length. (Harris.)

The following *Coleoptera* are also said by Dr. J. L. Leconte to affect the trunks and branches of the common hickory (*Carya tomentosa*).*

15. *Lyctus striatus* Melsheimer. Family BITOMIDÆ.
16. *Anthaxia viridifrons* Gory. Appeared April 10. Family BUPRESTIDÆ.
17. *Agrilus egenus*. April 21. Family BUPRESTIDÆ.
18. ——— probably n. sp. April 8. Family BUPRESTIDÆ.
19. *Phyllobænus dislocatus*. Family CLERIDÆ.
20. *Chariessa pilosa*. April 16. Family CLERIDÆ.
Sinoxylon basillare. Family PTINIDÆ. (See p. 74.)
21. *Heterachthes quadrimaculatus*. Family CERAMBYCIDÆ.
22. *Phyton pallidum*. May 20. Family CERAMBYCIDÆ.
23. *Molorchus bimaculatus*. Family CERAMBYCIDÆ.
Cyllene picta. (See p. 70.) Family CERAMBYCIDÆ.
Neoclytus erythrocephalus. Family CERAMBYCIDÆ.
24. *Tillomorpha geminata*. Family CERAMBYCIDÆ.
25. *Acanthoderes quadrigibbus*. Family CERAMBYCIDÆ.
26. *Liopus cinereus*. April 24. Family CERAMBYCIDÆ.
27. *Ecyrus dasycerus*. April 21. Family CERAMBYCIDÆ.
Saperda discoidea. (See p. 70.) Family CERAMBYCIDÆ.
Oncideres cingulatus. (See p. 71.) Family CERAMBYCIDÆ.
28. *Tribolium*, n. sp. March. Family TENEBRIONIDÆ.
29. *Læmosaccus plagiatus*. April and August. Family CURCULIONIDÆ.
30. *Xyleborus celsus*. Family SCOLYTIDÆ.
31. *Thysanoës fimbriicornis*. April and May. Family SCOLYTIDÆ.
32. *Chramesus hickoriae*. April and May. Family SCOLYTIDÆ.
33. *Eupogonius vestitus* Say. Bred from hickory. (Riley.)

AFFFECTING THE BARK.

34. THE HICKORY-BARK LOUSE.

Lecanium caryæ (Fitch).

Order HEMIPTERA; family COCCIDÆ.

Fixed to the bark of the small limbs, a large, very convex oval scale of a black color fading to chestnut brown, in May dusted over with a white powder. Length often 0.40 by 0.25 inch in width. (Fitch.)

35. THE HICKORY BLIGHT.

Eriosoma caryæ (Fitch).

Order HEMIPTERA; family APHIDÆ.

Forming a flocculent down coating the under side of the limbs, especially of bushes and young trees in shaded situations, multitudes of wooly plant lice.

The winged individuals are black, with the head, scutel, and abdomen covered with

* See American Entomologist, vol. iii, p. 236.

a white cotton-like substance, the fore wings with an oval salt-white spot near the tip of their outer margin; the veins being obsolete. Length to the tip of the wings 0.12 inch. On walnut bushes in Illinois. (Fitch.)

36. THE HICKORY APHIS.

Lachnus caryæ (Harris).

Order HEMIPTERA; family APHIDÆ.

Living in clusters on the under side of limbs of the pig-nut hickory early in July, very large plant-lice $\frac{1}{2}$ inch long, with no terminal stylet and very short honey tubes; body covered with a bluish white bloom or down, with four rows of little transverse black spots on the back; top of thorax and veins of wings black, as are also the shanks, feet and antennæ, while the thighs are reddish brown. (Harris.)

AFFECTING THE LEAVES.

37. THE LUNA SILK MOTH.

Actias luna (Linnaeus).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Devouring the leaves in August, a large thick-bodied caterpillar, about three inches long, apple green, each segment with six small bright rose-red elevated dots, and low down along each side a pale yellow line running lengthwise immediately above the lower row of dots, from which line at each of the sutures a pale yellow line extends upward upon the sides. Spinning a large oval cocoon, which is found among the fallen leaves; the moth, one of our largest insects, appearing late in May and during June; pale green, with eye-like spots in the center of each wing, the hinder pair prolonged into two long, broad "tails."

38. THE REGAL WALNUT CATERPILLAR.

Citheronia regalis (Hübner).

Order LEPIDOPTERA; family BOMBYCIDÆ.

A spiny caterpillar five inches long, our largest species, green, with a red head and tail, and stout, sharp, black and red spines, and black and red feet; not spinning a cocoon, but the larva enters the ground in September to transform to a chrysalis, which in July changes to a very large bright orange-red moth, with the fore wings pale olive spotted with yellow, the veins stained reddish, and the hind wings orange-red.

This is our largest caterpillar; it is harmless, though so formidable in appearance, and easily recognized by its size and by the four long horns on the segments just behind the head. It feeds on the black walnut, butternut, hickory, persimmon, and sumach, and is very rare north of New York, and is scarce in the Middle and Southern States.

39. THE HICKORY TUSsock MOTH.

Halesidota caryæ (Harris).

Order LEPIDOPTERA; family BOMBYCIDÆ.

In July and August and early September, eating the tender leaves at the ends of the branches, snow-white caterpillars, over an inch long, with rows of round black

spots, and along the back 8 black tufts of converging hairs and two black pencils of longer hairs near each end of the body; spinning in sheltered corners and crevices ash-gray oval cocoons; the moth appearing the following June. (Fitch.)

In certain years this caterpillar may be quite numerous; it is quite social, feeding in companies and is a general feeder, and, while preferring the walnut, butternut, and sumach, is common on the elm and ash, and Fitch says he has seen clusters of the caterpillars upon the tamarack or larch; he adds, what has been observed by ourselves, that as they approach maturity they separate and stray off to other trees, and may then be seen on rose bushes, on the apple, oak, locust, &c., the same individual often remaining several days in one place. It ranges from Maine to the Southern States.

The moth is very light ochre yellow; the long narrow-pointed fore wings are thickly sprinkled with little brown dots, and have two oblique brownish streaks passing backwards from the front edge, with three rows of white semi-transparent spots parallel to the outer hind margin; hind wings very thin, semi-transparent, and without spots. The wings expand about two inches. (Harris.)

40. THE SKIFF CATERPILLAR.

Limacodes scapha Harris.

Order LEPIDOPTERA; family BOMBYCIDÆ.

A singular boat-shaped triangular caterpillar, green, spotted above with brown pale beneath, the sides raised and the dorsal surface flattened; forming in the autumn a tough rounded oval cocoon, covered by an outer thin envelope.

The moth appears in June; it is light cinnamon brown; on the fore wings the costo-median region is filled in with a large tan-brown triangular spot, ending on the tip of the wing, and is lined externally with silver.

A number of other Bombycidæ allied to *Limacodes*, *Notodanta*, *Halesidota*, &c., also inhabit the hickory; besides these, the American silk worm sometimes occurs on the hickory, as well as the goldsmith beetle, which, according to Fitch, feeds on the leaves.



FIG. 35. — *Limacodes scapha*. Nat. size.

41. THE WALKING STICK.

Diaperomera femorata Say.

Order ORTHOPTERA; family PHASMIDÆ.

Sometimes stripping the leaves of the hickory, white oak, locust, &c., causing the timber to appear seared and leafless, a singular insect which would be mistaken for the smaller twigs or leaf-stalks, as the body is very long and slender, wingless, nearly four inches long, cylindrical, and an eighth of an inch in diameter.

A large number of Hemiptera, such as gall-lice, tree-hoppers, &c.,

puncture the leaves, causing them to wither or raising galls upon them.

The following species have been noticed by Fitch:

42. THE HICKORY-STEM GALL-LOUSE.

Phylloxera caryocaulis (Fitch).

Forming bullet-like galls, hollow, green, and of a leathery texture, upon the leaf-stalks and succulent young shoots, with the walls of the cavity inside covered with minute white and yellow lice.

43. HICKORY-VEIN GALL-LOUSE.

Phylloxera caryavenæ (Fitch).

Forming plaits in the veins of the leaves, which project up from the surface in an abruptly elevated keel-like ridge upon the upper side of the leaf and with a mouth opening on the under side, the lips of which are woolly and closed. The wingless females minute, pale yellow, broad in front, and tapering behind to an acute point; antennæ and legs short and tinged with a dusky hue.

44. THE HICKORY LEAF-WITHERER.

Phylloxera caryæfoliæ Fitch.

Forming small conical elevations on the upper surface of the leaf of *Carya alba*, each having an orifice in its summit; a very small black plant-louse with a pale abdomen and legs and smoky wings laid flat on its back, and having



FIG. 36.—The walking stick. *a*, *b*, eggs; *c*, young just hatching; *d*, male; *e*, female.—From Riley.

only three veins in addition to the rib. Length, 0.06 inch. (Fitch.)

45. THE SEED-GALL HICKORY PHYLLOXERA.

Phylloxera caryæ-semen (Walsh).

Forming fuscous, minute, subglobular, seed-like galls on the leaves of *Carya glabra*, the galls opening in a small nipple on the under side. (Walsh.)

46. THE HICKORY ROUND-GALL.

Phylloxera caryæ-globuli Walsh.

Forming hemispherical galls about 0.25 inch diameter on the upper surface of the leaves of *carya glabra* and *alba*, the galls rather flat below, where they open in a slit. (Walsh.)

47. THE HICKORY SPINY GALL.

Phylloxera spinosa (Shimer).

Forming large, irregular galls, covered with spines, on the petiole of the leaf of *Carya amara*, the galls opening beneath in an irregular, sinuate slit. (Shimer.)

48. *Phylloxera caryæ-septa* (Shimer).

Forming flattened galls with a septum, on the leaves of *Carya alba*, the galls opening both above and below. (Shimer.) Probably, according to Riley, only an abnormal form of *P. caryæ-globulis*.

49. *Phylloxera forcata* (Shimer).

Forming galls much like those of *P. caryæ-semen*.

50. *Phylloxera depressa* (Shimer).

Forming depressed galls on leaves of *Carya alba*, the galls opening below with a constricted mouth fringed with filaments. *Daktylosphæra coniferum* Shimer is, in all probability, Riley claims, the same. (7th Rep. Ins. Mo., p. 118.)

51. *Phylloxera conica* (Shimer).

Forming galls similar to those of *P. depressa*, but without the fringe. (Probably the same, Riley claims.)

. *Phylloxera caryæ-gummosa* Riley.

Forming pedunculated ovoid or globular galls on the under side of *Carya alba*; the gall white, pubescent, and gummy or sticky, opening below in a fibrous point.

The eggs are almost spherical, pale, and translucent. Larva, mother-louse, and pupa quite pale, the red eyes and eyelets strongly contrasting. (Riley, 7th Rep. Ins. Mo., p. 118.)

53. *Phylloxera caryæ-ren* Riley.

Forming numerous more or less confluent mostly reniform galls on the petiole and leaf-stems of *Carya glabra*; the galls varying from 0.2 to 0.7 inch in diameter, pale green and densely pubescent, and opening in a slit the whole of their length, transversely with the axis of the petiole. (Riley.)

54. *Phylloxera caryæ-fallax* Riley.

Forming conical galls thickly crowded on the upper surface of the leaves of the *Carya alba*. Strongly resembling *P. caryæ-foliæ*, but the height one-third greater than the basal diameter, and opening below, instead of above, in a circular fuzzy mouth. (Riley.)

55. THE HICKORY GAY-LOUSE.

Callipterus? caryellus Fitch.

Scattered upon the under side of the leaves, a small pale-yellow plant-louse with white antennæ alternated with black rings and pellucid wings laid flat upon its back, its abdomen egg-shaped, somewhat flattened, and with only minute rudimentary honey-tubes. (Fitch.)

56. THE DOTTED-WINGED GAY-LOUSE.

Callipterus? nunciatellus Fitch.

A plant-louse like the preceding, but with black feet and a black dot on the base and another on the apex of each of the veins of its fore wings. The stigma is salt-

white, with a brown streak at each end; the second vein is wavy, and at its tip is curved towards the tip of the first vein; the third vein arises from the basal extremity of the stigma, and forward of its furcation curves perceptibly towards the apex of the wing; the fourth vein is longer than the second fork. (Fitch.)

57. THE SPOTTED-WINGED GAY-LOUSE.

Callipterus? maculellus Fitch.

Differs from *C. ? caryellus* in having only a slender black ring at each articulation of the antennæ, the feet and a band near the tips of the hind thighs blackish; the stigma salt-white, its base black; its apex dusky; fourth vein with a black dot on its base and a dusky one on its apex; the first vein, apical third of the second vein, and the first and second forks broadly margined with smoky brown; second vein wavy and parallel with the third vein till near its tip where it curves towards the first vein, its base a third nearer the third than it is to the first vein; third vein arising from the anterior extremity of the stigma, with a dusky spot on its apex. (Fitch.)

58. THE SMOKY-WINGED GAY-LOUSE.

Callipterus fumipennellus Fitch.

Similar to the preceding, of a dull yellow color with blackish feet and the wings smoky with robust brown veins, the rib-vein much more distant from the margin of the first half of its length than in the other species, and from its middle to the stigma approaching the margin; the fourth vein equalling the stigma in length. (Fitch.)

59. THE BLACK-MARGINED GAY-LOUSE.

Callipterus marginellus Fitch.

Pale yellow; antennæ white, their bases and the four bands black; a coal-black band in front between the eyes and continued along each side of the thorax to its base; fore wings pellucid, stigma with the outer margin and rib-vein coral black, first vein with a black dot on its base; fourth vein slender, black, the other veins colorless; outer margin of hind wings black. (Fitch.)

60. THE FRECKLED LEAF-HOPPER.

Jassus inoratus Say.

A cylindrical oblong white leaf-hopper closely inscribed and reticulated with slender black lines and small dots which form irregular spots along the margins of the wing-covers; its legs white dotted with black. Length, 0.25 inch.

61. FOUR-STRIPED LEAF-HOPPER.

Diedrocephala quadrivittata (Say).

A flattened oblong leaf-hopper of a light-yellow color, varied on the thorax with orange, red or dusky; its fore wings olive green, each wing with two bright red or orange stripes, the tips margined with black. Length, 0.35 inch. (Fitch.)

62. THE WALNUT SWORD-TAIL.

Uroxiphus caryæ Fitch.

A dull brown tree-hopper with the terminal portion of its fore wings obscure ash-gray; its abdomen and a ring on its shanks pale yellowish, and its breast mealy white. Length of male, 0.30; female, 0.37. (Fitch.)

63. THE YELLOW TREE-HOPPER.

Telamona unicolor Fitch.

A tree-hopper of a uniform dull ochre-yellow, somewhat like a beech-nut in shape and size, with a prominent hump jutting up on the middle of its back, highest anteriorly and descending with a slight curve to its hind angle, which is very obtusely rounded and but little prominent; its anterior angle also rounded and with only a slight concavity below it at the forward end of the hump, while at its posterior base is a strong one, the whole surface with close coarse punctures and showing a few elevated longitudinal lines low down on each side and towards the tip; the upper edge of the hump black and also the tip of the abdomen on its under side; fore wings glassy, with a black spot on their base and tip, and their veins margined with slender black lines. Length, 0.45 inch; height, 0.25 inch.

64. THE BANDED TREE-HOPPER.

Telamona fasciata Fitch.

Like the preceding species, but smaller and of a tawny yellow color, its head and the anterior edge of the thorax and the under side paler cream-yellow or straw-colored; with a single small black dot above each eye; its thorax in front and at tip blackish, and also an oblique band across the hind end of the dorsal hump longer than high, longer at its base than above, highest anteriorly, with a stronger concavity at its anterior end than at its posterior, and at its anterior base compressed and forming hereby a shallow indentation upon each side. Length, 0.38; height, 0.20 inch. (Fitch.)

65. THE SHORT-HORNED TREE-HOPPER.

Ceresa brevicornis Fitch.

Very like *Ceresa bubalus* on the apple and wild thorn, but differing in having the horns much shorter, while the sides of the thorax, when viewed in front, are not gradually curved outwards, but are straight or rectilinear, with the horns abruptly projecting from the corner at the upper end of this line. The acute spine at the tip of the thorax is also longer and slenderer. The thorax between the horns is slightly convex. The dried specimen is of a pale dull yellow color speckled with faint pale green dots and with a paler straw-colored stripe, quite distinct, upon the angular sides of the thorax from each eye upward to the horn and from thence to the summit of the thorax. Length, 0.36 inch. (Fitch.)

66. THE FACE-BANDED CIXIUS.

Cixius oinctifrons Fitch.

A small four-winged hemipter of a white color, varied with blackish brown, and with three elevated lines upon the face and thorax; its face snow-white, crossed by two black bands, the outer raised lines dotted with white in these bands; the thorax black, tawny yellow on each side beyond the raised lines; neck white with a row of blackish dots upon each side; fore-wings smoky brown, their veins dotted with black in places, their basal edge, an oblique band and a spot in the middle of the outer margin white, their membranous tips white and somewhat hyaline, with a brown band across the transverse veinlets, and the hind margin blackish, interrupted by the snow-white tips of the veins; hind wings black and transparent; under side yellowish white with two blackish bands on each of the four forward shanks. Length, 0.18 inch.

67. THE CLOUDY-TIPPED CIXIUS.

Cixius colapsum Fitch.

Rarely found on the leaves, a small four-winged homopter of a coal-black color, with clear, transparent wings having a large smoky-brown cloud on their tips; fore-

wings transparent, their veins dotted with black, the dots on the outer margin larger; an irregular and somewhat broken band of a smoky-brown color extending across forward of the middle and a broader one beyond the middle, having a black spot or stigma on the anterior corner of its outer end; between these bands a smoky-brown spot on the inner and a smaller one nearly opposite it on the outer margin; thorax with three raised lines; face black with the raised lines brown; legs dull whitish. Length, 0.22 inch. (Fitch.)

68. AMYOT'S OTIOCERUS.

Otiocerus amyotii Fitch.

A light yellow homopter; the wing-covers pale sulphur-yellow, with a brown stripe from the base to the middle of the inner margin and thence to the outer tip; a row of blackish dots on the hind edge alternating with the ends of the apical veins, and about six dots forward of the innermost of these, placed on the tips of the subapical and on the bases of the apical veins; three brown stripes on the thorax; an orange-red stripe on each side of the head, from the eye to the forward edge below the apex. Length, 0.25; expanse of wings, 0.70 inch. (Fitch.)

69. THE LARGE GREEN TREE BUG.

Rhaphigaster pensylvanicus (De Geer).

A large flattened grass-green bug (hemipter) edged all around with a light yellow line, interrupted at each joint of the abdomen by a small black spot, its antennae black beyond the middle of their third joint, with a pale yellow band on the first half of the two last joints. Length, 0.60 and 0.70 inch. (Fitch.)

70. THE WALNUT LEAF-ROLLER.

Tortrix rileyana Grote.

Order LEPIDOPTERA; family TORTRICIDÆ.

Drawing together the leaves of the black walnut and hickory in May, a colony of small yellow caterpillars; late in the month changing to honey-yellow chrysalids, the moths escaping by the middle or last of June. The latter expands an inch, and is deep ochreous, the fore-wings broad, evenly washed with purplish, with dark velvety-brown small spots, of which there are three at the base, two in the middle of the wing, and one on the edge, while near the apex is a curved row of four or five spots. The hind wings clear bright deep ochreous yellow. (Riley.)

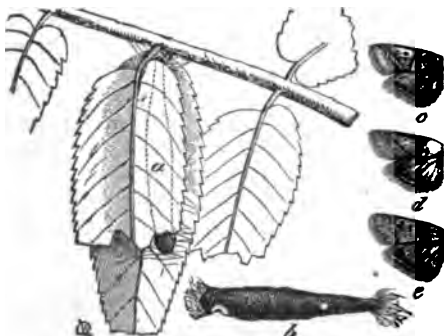


FIG. 37.—Walnut case-bearer; a, case between two leaves; b, case; c, *A. nebulo*; d, *A. juglandis*; e, *A. juglandis* var.

71. THE WALNUT CASE-BEARER.

Acrobasis juglandis Le Baron.

Order LEPIDOPTERA; family PYRALIDÆ.

Drawing two leaflets together and constructing a black case, a small dark greenish worm, changing to a gray narrow-winged small moth. (Fig. 20.—Riley IV, p. 42.)

We have observed at Providence, June 1st, between the folded leaves of *Carya porcina*, a similar case, but in the form of a long, slender black cone.

72. PIG-NUT LEAF WEEVIL.

Conotrachelus elegans Say.

Order COLEOPTERA; family CURCULIONIDÆ.

While engaged in laying its eggs sometimes cutting off the leaves of the pig-nut hickory, a weevil of moderate size, closely resembling the plum weevil.

We have observed this weevil at Providence, busily engaged the last of May laying its eggs in the partly rolled-up leaves of the pig-hickory (*Carya porcina*), and during the process cutting off the leaves, which hang down, wither, and turn black.

73. THE PIG-HICKORY SLUG-WORM.

Selandria sp.

A pale-green slug-worm, resembling in form the naked larva of *Selandria caryæ*, with several rows of short, forked white hairs; quite abundant at Providence May 30th, eating roundish holes in the leaves of the pig-nut hickory.

74. THE HICKORY SLUG CATERPILLAR.

Thecla calanus (Hübner).

Order LEPIDOPTERA; family PAPILIONIDÆ.

Feeding on the leaves of the pig-hickory at Providence May 30th and later, a pale-green, flattened, long, oval, cylindrical caterpillar, flat beneath; the body rounded above and covered with short hairs; changing to a delicate small butterfly, with the hind wings tailed.

AFFECTING THE FRUIT.

75. THE HICKORY-SHUCK WORM.

Ephippophora caryana Fitch.

Order LEPIDOPTERA; family TORTRICIDÆ.

Mining the shucks which envelope the nuts, causing them to be abortive and many to fall from the tree prematurely, a slender white sixteen-footed caterpillar about three-eighths of an inch in length.

The moth is sooty black, the fore-wings with reflections of tawny yellow, blue and purple; their outer edge black with oblique triangular whitish streaks placed at equal distances apart. A very oblique faint silvery blue streak extends inwards from the points of two of these white streaks, namely, the fourth and sixth ones from the tip of the wing; while the usual white spot on the inner margin of the wings is wanting. Expanse of wings, 0.60 inch. (Fitch.)

76. THE HICKORY-NUT WEEVIL.

Balaninus nasicus Say.

Order COLEOPTERA; family CURCULIONIDÆ.

A worm like the chestnut borer transforming into a long-snouted beetle closely like *B. rectus*, but with a darker, thicker, more curved rostrum, and with the antennæ springing from its middle in the male and from its basal third in the female. Two

thoracic paler bands are seen on the thorax, and there is always a pale transverse band behind the middle of the elytra, and a sutural band. In the male the beak is equal to three-fourths the length of the body; in the female to five-fourths. It breeds entirely on hickory nuts. (Riley.)

The following insects also occur on the hickory:

77. The Luna moth, *Actias luna*. (Linn.)
78. The hickory leaf roller, *Tortrix* (*Lophoderus*) *juglandana* Fernald. (Can. Ent. XI, 155.)
79. *Eburia quadrigemina* Say. Issuing from hickory trees in July, common. (McBride.)

The following Tineidæ feed on the hickory according to Chambers:

80. *Lithocolletis caryæfoliella* Clem.
81. *Lithocolletis caryæalbella* Chamb. Larva in a tentiform mine in the under surface of the leaves.
82. *Aspidisca lucifluella* Clem. Larva in a small blotch mine, from which it cuts out its pupal case.
83. *Coleophora caryæfoliella* Chamb. (and Clemens?). Larva feeds in a cylindrical case attached to the under surface of the leaves.
84. *Nepticula caryæfoliella* Clem. Imago unknown. Larva in a linear crooked mine on the upper side of the leaves.
85. *Ypsolophus caryæfoliella* Clem. Larva sews together the leaves.
86. *Gracilaria* sp. (probably *G. blandella* Clem.) Imago unknown. The larva when young makes a linear whitish mine in the upper surface of the leaves.
87. *Phycita nebulo* (juglandis). A pyralid living on the walnut.

INSECTS INJURIOUS TO THE BLACK WALNUT.

(*Juglans nigra*.)

AFFECTING THE TRUNK.

The chief enemy of this tree is the hickory and locust tree borer, (*Cyllene picta*). Fitch states that the beetles which are reared in this tree appear to constitute a distinct variety of a larger size than usual and with their yellow marks changed more or less to a white color.

AFFECTING THE LEAVES.

1. THE BLACK WALNUT SPHINX.

Smerinthus juglandis Smith-Abbot.

Order LEPIDOPTERA; family SPHINGIDÆ.

A large pale blue-green caterpillar with a long caudal horn; head small, and the body attenuated before and behind, and with seven oblique white bands. When disturbed it makes a creaking noise by rubbing together the joints of the fore part of the body. It enters the earth to finish its transformations. (Harris.)

The moth is very gray, dark or dusky brown; wings indented on the outer edges; fore-wings with a dusky outer margin, a short brownish dash near the middle, and four transverse brown lines converging behind and enclosing a square dark brown

spot adjacent to the middle of the inner margin; hind wings with two narrow transverse brown lines between two brownish bands; thorax with a central brown line; abdominal segments plaited and prominent at the sides. The wings expand from 2½ to 3 inches. The females are much larger and of a lighter brownish gray color than the males, with the square spot on the fore-wings less distinct. Ranges from Massachusetts to Florida and Georgia. (Harris.)

2. THE RED-TAILED ATTELABUS.

Attelabus analis Weber.

Order COLEOPTERA; family CURCULIONIDÆ.

Rolling up the leaves of the oak and black walnut, a weevil a quarter of an inch long, with a long, slender, cylindrical head and short, broad, thick body. The antennæ, legs, and middle of the breast deep blue-black; the thorax, wing-covers, and abdomen dull red; the wing-covers, taken together, nearly square and pitted in rows.

According to Harris, this pretty weevil is found on the leaves of oak trees in June and July. Mr. George Hunt has observed it on the walnut in May before the buds open, at Providence.

The following insects also occur on the black walnut:

3. Walnut leaf-roller, *Tortrix rileyana* Grote.
4. Walnut case-bearer, *Acrobasis juglandis* Le Baron.
5. The Luna moth, *actias luna* (Linn).
6. *Conotrachelus juglandis* (Lec). Larva taken from walnuts, Mt. Carmel, Illinois, H. Shimer, Mus. Peab. Acad. Science, Salem, Mass. (See Harris, p. 77.)

The following leaf-miners are enumerated by Mr. Chambers, with the notes appended:

7. *Lithocolletis caryæfoliella*. Larva in irregular blotch-mine in upper surface of leaves.
8. *Gracilaria blandella* Clem. Larva when small in a linear whitish mine in upper surface of leaves, afterwards feeding and pupating under the turned-down edge.
9. *Gracilaria juglandinigræella* Chamb. Larva at first mining the leaves beneath, afterwards feeding and pupating under the turned-up edge.
10. *Aspidisca juglandiella* Chamb. Larva in a very small blotch-mine, from which it cuts out a case in which it pupates.
11. *Nepticula juglandifoliella* Chamb. (and Clemens?) Larva in small, linear crooked mines; sometimes many in a leaf. Mine in upper surface.

INSECTS INJURIOUS TO THE BUTTERNUT.

(*Juglans cinerea*.)

AFFECTING THE TRUNK AND LIMBS.

1. THE SPOTTED LEPTOSTYLUS.

Leptostylus macula (Say).

Order COLEOPTERA; family CERAMBYCIDÆ.

Under the bark of old decaying trees a longicorn larva, changing to a pupa in its cell and early in July giving out a small thick long-horned beetle of a brown or chest-

nut color with the sides of its thorax and a band on its wing-covers ash-gray, the latter sprinkled over with coarse punctures and large blackish dots, the thorax on each side of its disk with a black stripe interrupted in its middle. Length, 0.25 inch.

Dr. Fitch, in his third report; states that the bark of old trees will sometimes be found everywhere filled with these grubs, which in the month of June may be seen changed to short thick pale-yellow pupæ, with a few perfect insects that are newly hatched and have not yet left the tree.

2. THE MUSCLE-SHAPED BUTTERNUT BARK-LOUSE.

Aspidiotus (Mytelapis) juglandis Fitch.

Order HEMIPTERA; family COCCIDÆ.

Fixed to the bark of the twigs, minute pale brownish scales, like those of the apple bark-louse, but smaller and not curved; preyed upon by a minute chalcid fly. (Fitch.)

3. THE HEMISPHERICAL BUTTERNUT SCALE INSECT.

Lecanium juglandifex Fitch.

Adhering to the bark on the under side of the limbs, a hemispherical dull yellowish or black scale about 0.22 inch long and 0.18 broad, notched at its hind end, frequently showing a paler stripe along its middle and a paler margin and transverse blackish bands. (Fitch.)

The males, according to Fitch, are long and narrow, delicate two-winged flies, measuring 0.05 inch to the tip of the abdomen and a third more to the ends of the wings. They are of a rusty reddish color, the thorax darker and the scutel and head blackish, this last being separated from the body by a narrow pale-red neck. The antennæ are slender and thread-like, half as long as the body and eight-jointed. Two slender white bristles as long as the body are appended to the tip of the abdomen. This description will apply to most of the males of other species of *Lecanium*.

AFFECTING THE LEAVES.

4. THE BUTTERNUT WOOLY WORM.

Selandria caryæ Norton.

Order HYMENOPTERA; family TENTHREDINIDÆ.

On the under side of the leaves companies of saw-fly larvæ covered with long dense snow-white wool standing up in flattened masses entirely concealing the green worm, eating the leaflets from the outer edge inward, often leaving nothing but the mid-ribs.

These remarkable objects occasionally, though rarely, appear on the butternut in July. The worm presents the appearance (as described in our "Guide to the Study of Insects," from which the following description and figures are taken) of an animated white woolly or cottony mass nearly an inch long and two-thirds as high. The head of the larva is

rounded, pale whitish, and covered with a snow-white powdery secretion, with prominent black eyes. The body is cylindrical, with eight pairs of soft fleshy abdominal legs; the segments are transversely wrinkled, pale pea-green, with a powdery secretion low down on the sides, but above and on the back arise long flattened masses of flocculent matter (exactly resembling that produced by the wooly plant lice and other homopterous insects), forming an irregular dense cottony mass, reaching to a height equal to two-thirds the length of the worm, and concealing the head and tail. On the 27th and 28th of July the larvæ molted, leaving the cast skins on the leaf. They were then naked, a little thicker than before, of a pale-green color, and their bodies were curled upon the leaf.



FIG. 38.—The butternut wooly worm and the same deprived of its coat.—From Packard.

The worms eat out the edge of the leaf. Some time during August two cocoons were spun between the leaves, but I did not succeed in raising the saw-flies. On describing the larvæ in a letter to Mr. E. Norton, our best authority on this hymenopterous family, he kindly sent me alcoholic specimens of the larvæ (without the woolly substance, which dissolves and disappears in alcohol) found feeding on the hickory, which are, apparently, from the comparison of alcoholic specimens, identical with the butternut *Selandria*. The adult fly he named *Selandria carya*, and his descriptions are given below.

Previously to this and without my knowledge, Dr. Fitch, under the name of *Selandria? juglandis*, had apparently briefly described in his third report the same insect, but he was unacquainted with the perfect insect, and was in doubt as to whether the larva was a *Selandria* or not. Under these circumstances we retain Mr. Norton's name. From his account it would appear that the insect also feeds on the hickory (*Juglans squamosa*).

Female.—Color shining black. The pro and meso-thorax and scutellum rufous, the apex of the latter black; the nasus and legs white, with their tarsi blackish; the base of coxæ and a line down the upper side of the legs black. Antennæ short; the second joint as long as the first; the four final joints together not longer than the two preceding. Nasus slightly incurved. Claws of tarsi apparently bifid. Wings subvioletaceous; lanceolate cell petiolate, the first submedian cell above it with a distinct cross-vein. Under wings with one submarginal middle cell (all other species have this cell discoidal), the marginal cell with a cross-nervure, and all the outer cells closed by an outer nervure, which does not touch the margin. The submedian cell extended nearly to the margin. Length, 0.25 of an inch. Expanse of wings, 0.40 of an inch.

The male resembles the female, but the under wings are without middle cells.

The larva feeds upon the leaves of the hickory (*Juglans squamosa*). They are found upon the lower side of the leaf, sometimes fifteen or twenty upon one leaf, which they eat from the outer extremity inward, often leaving nothing but the strong midribs. They cover themselves wholly with white flocculent tufts, which are rubbed off on being touched, leaving a green twenty-two-legged worm, about 0.75 inch in length

when fully grown; darkest above, and with indistinct blackish spots upon the sides. The head is white, with a small black dot upon each side. Specimens were taken upon the leaves July 4. Went into the ground about the 20th of July. The cocoon is formed near the surface of the ground of a little earth or sand drawn together. Four specimens came forth about August 22, all seemingly very small for so large larvæ. (Norton in Packard's Guide to the Study of Insects.)

5. THE TWO-MARKED TREE-HOPPER.

Euchenopa binotata Say.

Order HEMIPTERA; family MEMBRACIDÆ.

Puncturing the leaves and extracting their juices from July till the end of the season, a small rusty brown or black tree-hopper, with two bright pale yellow spots upon its back, which part is prolonged forward and upward into a compressed horn rounded at its tip and giving the insect a resemblance to a little bird with an out-stretched neck, and the four forward shanks broad, thin, and leaf-like. Length, 0.25 to 0.30 inch. (Fitch.)

6. THE BUTTERNUT TREE-HOPPER.

Ophiderma mera Say.

Belonging to the same family as the preceding, a greenish-gray tree-hopper, shaped like a half cone, with its apex bright chestnut-red, and behind its middle a black band which is sometimes interrupted on the summit of the back, and with a blackish spot on the tips of the hyaline fore wings. Length 0.36 inch. (Fitch.)

7. THE OBTUSE CLASTOPTERA.

Clastoptera obtusa Say.

A short thick almost circular leaf-hopper of a gray color, with fine transverse wrinkles and three brown bands anteriorly, its fore wings clouded with tawny brown with streaks of white and a coal-black spot near their tips. Length 0.22 inch, (Fitch.)

8. THE BUTTERNUT TINGIS.

Tingis juglandis Fitch.

Puncturing the leaves and sucking their juices, a small singular bug, resembling a flake of white froth, its whole upper surface composed of a net-work of small cells, an inflated egg-shaped protuberance like a little bladder on the top of the thorax and head, the sides of the thorax and of the fore wings, except at their tips, minutely spinulose; the fore wings flat and square with their corners rounded, a large brown or blackish spot on the shoulder, and a broad band of the same color on their tips, with an irregular whitish hyaline spot on the inner hind corner; the body beneath, small and black, the antennæ and legs honey-yellow. Length 0.14 inch. (Fitch.)

Fitch remarks that this insect becomes common on the leaves of the butternut in May, and continues through the summer and autumn. It may sometimes be met with also on the birch, willows, and other trees. We have found it in abundance on the butternut at Brunswick, Me., late in August in all stages of growth.

9. THE VIRGINIA TIGER-MOTH.

Spilosoma virginica (Fabricius).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Occasionally devouring the leaves of the butternut, a very hairy, deep yellow caterpillar, with a black head and body, the latter mottled with black; changing to a thick chrysalis within a cocoon, where it remains until the following June, when it appears as a white moth.

This omnivorous caterpillar, commonly called "the yellow bear," is known to feed on the butternut, grape vine, current, gooseberry, grasses,

and various garden vegetables, and we have found it from the first to the middle of September in Maine feeding on the buckthorn and also the pitch-pine. According to Harris there seems to be two broods of caterpillars and two of the moths. The caterpillars, he states, "are to be found of different ages and sizes from the first of June till October. When fully grown they are about two inches long, and then creep into some convenient place of shelter, make their cocoons, in which they remain in the chrysalis state during the winter, and are changed to moths in the months of May or June following. Some of the first broods of these caterpillars appear to come to their growth early in summer, and are transformed to moths by the end of July or the beginning of August, at which time I have repeatedly taken them in the winged state; but the greater part pass through their last change in June." I have observed the full-grown caterpillar at Brunswick, Me., the first and second weeks in August; they spin from the middle of August till September. The following description of the caterpillar is taken from my notes:

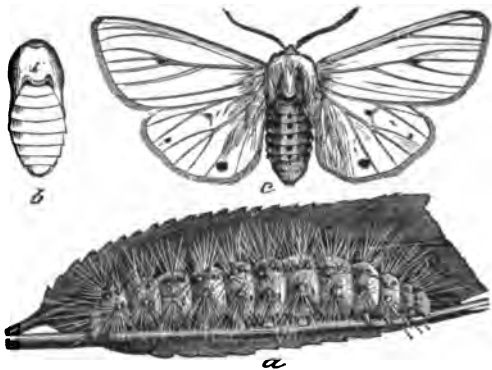


FIG. 39.—c, Virginia tiger-moth; a, its caterpillar; b, chrysalis, all nat. size.—After Riley.

The caterpillar.—Head of moderate size; body cylindrical, rather short and not very convex; each segment with four tubercles above, two smaller median ones being situated in front of and between two latero-dorsal larger ones; three tubercles on each side of each segment, all giving rise to dense verticils of long uneven fox-yellow hairs; most of the hairs are as long as the body is thick, while others on the back are twice as long, so that in outline the larva is an elongated ellipse, the head and tail being alike concealed by the spreading hairs. The body and head is black or yellowish mottled with black. The hairs are tawny yellow, while the short hairs on the sides of the thoracic rings are black.

The moth.—Snow white, with a black dot in the middle of the fore wings and two on the hind wings; a row of black spots along the back of the abdomen and a row along the sides, between the latter dots a longitudinal deep yellow stripe; the basal joints of the fore legs are yellow. The wings expand about two inches. The eggs are said by Harris to be golden-yellow, and to be laid in patches on the leaves of plants.

Besides this moth the following *Lepidoptera* occur at times on the butternut:

10. The hickory tussock moth, *Halesidota caryæ*, Brunswick, Maine.
11. The vaporor moth, *Orgyia leucostigma*.
12. The fall web-worm, *Hyphantria textor*. (See p. 67.)
13. The Luna moth, *Actias luna* (Linn.). (See p. 76.)
14. The Cecropia moth, *Samia cecropia*.

15. The American silk worm, *Telea polyphemus*. (See p. 47.)
16. The black walnut sphinx, *Smerinthus juglandis*. (See p. 84.)
17. The butternut leaf-miner, *Lithocolletis caryæfoliella* Clem.
18. The locust or hickory borer, *Cyrtene picta* (Drury). (See p. 70, 95.)

INSECTS INJURIOUS TO THE CHESTNUT.

(*Castanea vesca*.)

AFFECTING THE TRUNK AND LIMBS.

1. THE CHESTNUT TREE BORER.

Making a zigzag burrow under the bark, and sometimes descending nearly 2 inches towards the heart of the tree where it may spend the winter, a longicorn larva nearly $\frac{1}{2}$ inch long, dirty white, of much the appearance of the hickory or locust tree borer, and transforming in its chamber into the beetle state.

Although the chestnut has been supposed to be remarkably free from borers, we have found that in Rhode Island the trunks are quite liable to the attacks of a borer, which we have not yet traced to the beetle, but which will probably prove to be the species next mentioned (*Arhopalus fulminans*), since this beetle, which is known to inhabit the chestnut, is closely allied to the locust borer in its form, while the larva is also closely like that of *Cyrtene picta* and the different species of *Olytus*. The burrows in outline are flattened, cylindrical, being adapted to the broad flattened front part of the body of the larva. The burrows begin as small zigzag galleries about a line in width and 4 inches long, making about three turns at nearly right angles in this space; they are filled with the castings of the worm; as the larva grows larger it sinks deep in towards the heart of the tree, when the burrow in the deepest part becomes packed with large, long, curved chips, apparently bitten off by the grub for the purpose of forming a chamber, the partition of chips possibly serving to keep out the cold during its winter's sleep.

2. THE BROWN CHESTNUT BEETLE.

Arhopalus fulminans (Fabricius).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring into the trunk, a grub like the foregoing, if not the same insect, which transforms into a dark brown beetle with dark blue reflections, and the wing-covers crossed by four zigzag fine gray lines.

The following notice of this beetle is taken from my Second Report on the Injurious Insects of Massachusetts (1872):

My attention has been called by Mr. R. B. Grover, a student in the State Agricultural College, to the fact that the *Arhopalus fulminans* Fabr. (Fig. 40, enlarged twice), one of the family of longicorn beetles, bores in the trunk. I know nothing further concerning its habits nor of the appearance of its grub. The beetle itself is blackish brown, with slight dark-blue reflections; the legs and antennæ are of the same color,

the latter being scarcely longer than its body. the prothorax and under side of the body are covered with a pale-gray pile, while certain silver markings on the wing-covers are composed of similar close-set, fine hairs. The hairs on the sides of the prothorax inclose a conspicuous black spot, while the top is black, and more coarsely punctate than the wing-covers. The latter are each crossed by four acutely zigzag lines, composed of microscopic hairs, forming **W**-like bands on the elytra, the basal lines being less distinctly marked than the others. The ends of the wing-covers are also tipped with gray, especially on the inner side of the end. The legs are pitchy brown with light hairs, and with a reddish tinge on the terminal joints (tarsi). It is a little over half an inch long.

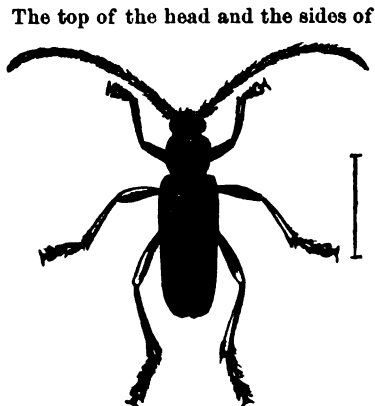


FIG. 40.—Chestnut Borer. —From Packard.

3. THE NOBLE CHESTNUT BORER.

Calloides nobilis (Say).

A longicorn borer, probably depredating upon the chestnut, and transforming to a large, handsome, black brown beetle, nearly an inch long, marked with three broken yellow lines and a pair of large round yellow dots on the wing-covers.

Mr. George Hunt informs us that he has found this noble Clytus under the bark of the chestnut at Providence; hence it occurs as a borer of this tree. Its food-tree has not heretofore been known.

4. THE TWO-TOOTHED SILVANUS.

Silvanus bidentatus (Fabricius).

Order COLEOPTERA; family ATOMARIIDÆ.

Under the bark of logs and decaying trees, probably loosening the bark from the wood, a minute, narrow, flattened beetle, of a light chestnut-brown or rust-color, its thorax longer than wide, slightly narrowed towards its base and with a small tooth projecting outwards at each of its anterior angles. Length, 0.10 to 0.12 inch. (Fitch.)

Fitch observes that this is an European insect, which, like a kindred species, the Surinam Silvanus, has now become perfectly naturalized and as common throughout the United States as it is in its native haunts. On stripping the bark from recently cut logs of chestnut and of oak, this minute beetle, which is so flattened and thin that it can creep into the slightest crevices, will be found frequently in considerable numbers.

The beetle.—The head and thorax often of a darker shade than the wing-covers; the latter with rows of close punctures with a slightly elevated line between each alternate row. Its thorax also is densely and confluent punctured, and commonly shows a very faint elevated longitudinal line in its center. The angles at its base on each side are obtuse, and from these angles forward to the projecting tooth the lateral edges are crenate-dentate, having sixteen little elevated tubercles or minute teeth jutting out at equal distances along the margin. The point of the large anterior tooth

forms a right angle. Upon each side of the head behind the eye is also a minute tooth of the same size with those along the sides of the thorax. The surface is slightly clothed with minute inclined bristles. (Fitch.)

5. THE NOTCHED-WINGED GEOMETER MOTH.

Eugonia alniaria Hübner.

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding on the chestnut, a bluish-green caterpillar, with wrinkles, and on the eleventh segment two little warts tipped with brown; transforming to a light ochre-yellow moth with wings deeply notched.

This caterpillar was found by Mr. L. W. Goodell on the chestnut at Amherst, Mass., August 20; on the 21st it drew a few leaves together, and spun a thin, silky, pear-shaped cocoon; became a chrysalis the 24th, and was transformed to a moth September 13.

Larva.—Body two and three-tenths inches long, the body largest near the tail, and tapering to the head; bluish green, with a thick wrinkle on each ring, those on the fifth and eighth thickest and light-brown; on the back of the eleventh ring two little warts tipped with brown. (L. W. Goodell.)

Pupa.—One and two-tenths inches in length, bluish-white, ending in a flattened tail, tipped with black, and on each edge three small black spines, each ending with a minute hook. (Goodell.)

Moth.—Short bodied, quite hairy; male antennæ heavily pectinated, wings deeply scalloped; delicate ochre-yellow, with a reddish tinge towards the edge of the wings, and on the head and front of the thorax. Fore wings with two lines, often interrupted, or only developed on the costa; inner line on the inner third of the wing; the curved outer line, beginning near the inner, diverges and follows a sinuate course, ending much nearer the apex than the inner line, the distance varying; both wings speckled, sometimes thickly, with unusually large spots; outer edge of both wings deeply excavated, especially opposite the second median venule. Hind wings with no lines, only an obscure discal dot. Expanse of wings two and two-tenths inches.

This moth ranges from Maine to Missouri. The larva is also described by Mr. S. H. Scudder as living on the black birch. But his description given in my Monograph of the Phalænidæ (p. 530) is so different from Mr. Goodell's that I fear it refers to a different insect.

AFFECTING THE LEAVES.

6. THE CHESTNUT TREE-HOPPER.

Smilia castaneæ Fitch.

Order HEMIPTERA; family MEMBRACIDÆ.

Puncturing the leaves and extracting their juices in July, a triangular tree-hopper, shaped much like a beechnut, of a blackish color, tinged with green more or less when alive, its head and the anterior edges of its thorax and all beneath bright yellow, its fore-wings clear and glassy, with a blackish spot on their tips and another on the base, which is often prolonged along the middle of the wing and united with the hind spot. Length of male, 0.25; female, 0.30 inch. (Fitch.)

7. THE UNADORNED TREE-HOPPER.

Smilia inornata Say.

A tree-hopper of the same size and shape as the preceding, but of a light green color fading to light yellow, with a slender black line along the upper edge of its back, and a very slight duskiness on the tips of its glassy wings. Common on chestnuts and oaks from July to the last of September. (Fitch.)

8. THE CHESTNUT GAY-LOUSE.

Callipterus castaneæ Fitch.

Order HEMIPTERA ; family APHID.E.

On the under sides of the leaves, puncturing them and sucking their juices in August and September, a small sulphur-yellow plant-louse, with black shanks and feet, its antennæ also black except at their bases and as long as the body, its wings pellucid, their first and second oblique veins and the tip of the rib-vein edged with coal-black, and its thighs straw yellow. Length, 0.09 ; expanse of wings, 0.15 inch. (Fitch.)

9. THE CHESTNUT PHYLLOXERA.

Phylloxera castaneæ (Haldeman).

In August and September, on both sides of the leaves, puncturing them and extracting their juices and causing them to curl, a very small louse-like fly of a bright sulphur-yellow color, with a black thorax, breast, and eyes, its feet and antennæ tinged with blackish and its wings translucent. The wingless individuals associated with it are entirely yellow, with red eyes. (Haldeman.)

AFFECTING THE FRUIT.

10. THE CHESTNUT WEEVIL.

Balaninus caryatrypes (Boheman).

Eating large cavities in the meat of the chestnut; a soft, white, footless grub, attaining its full size when chestnuts are ripe, and remaining in the nuts through the winter; transforming into a weevil with an exceedingly long and slender beak.

The chestnut is often infested by a large white maggot (Fig. 10, larva of *Balaninus* and chestnut infested), with a yellowish head, which attains its full size at the time the nuts drop. It is found in nuts sent

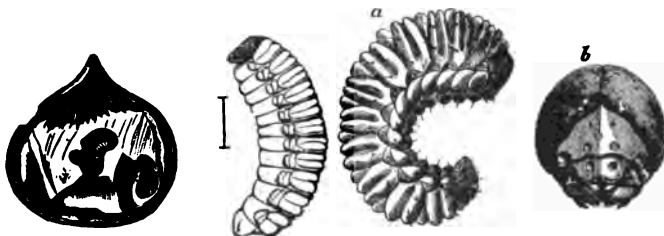


FIG. 41.—Chestnut Maggot. a, a second, better drawn, view; b, head.—From Packard.

to market, and it is probable that while some of the maggots gnaw their way out, and enter the ground in the autumn to transform, others delay until the spring. The worm devours nearly a third or one-half of the interior of the nut, part of the cavity being filled with the castings of

the worm. As the grub is white it is liable to be overlooked and eaten with the chestnut; it makes its exit through a round hole in the shell.

The larva is about a third of an inch long, cylindrical, and of nearly the same thickness from the head to the tail. It is completely footless as are nearly all nut-inhabiting larvæ. It is very difficult to rear this insect, as I have found after successive trials, and I am indebted to Mr. G. Mooney, of Providence, Rhode Island, for a fresh male and female beetle reared by him from chestnuts collected in Providence. On sending one of the specimens to Dr. G. H. Horn, he kindly identified it as *Balaninus caryatripes*.

Dr. LeConte, in his work on "The Rhynchophora of America," remarks that the beak of these weevils "attains in length and attenuation the greatest development; in the male it is rarely shorter than the body; in the female it is frequently twice the length, and is used to make the perforation into which the egg is subsequently introduced. The great thickness of the husks of the fruits (chestnuts, walnuts, hickory nuts, &c.) depredated on by these insects necessitates a very long perforating instrument to reach the kernel, upon which the larva feeds."

11. THE CHESTNUT CATERPILLAR.

Devouring the inside of chestnuts the larva of a moth which grows to more than half an inch in length, and is cylindrical and thick, of a dirty white color, with a tawny yellow head, and sixteen feet. It eats the meat of the nut mostly at its tip and on its convex side, the cavity which it makes being filled with little brown and whitish grains; and a small hole is perforated upon one side of the nut at its tip, out of which a portion of these grains is protruded. (Fitch).

Besides the chestnut grub or weevil, Dr. Fitch gives an account of this larva of a moth which he has found in chestnuts, but which he did not rear.

The following insects also prey upon the chestnut:

12. The larva of the American maple moth, *Apatela americana* Harris.
13. The American white ant (*Termes frontalis* Haldeman) sometimes mines and wholly consumes the interior of chestnut fence posts and stakes, while the outer surface remains entire. It also mines old elm, pine, and other decaying trees, as well as the sills of houses.
14. *Lithocolletis castaneæcella* Chamb. Larva in a blotch upper-surface mine in the leaves.
15. *Lithocolletis* sp. Image unknown. Larva in tentiform mine in under surface of leaves.
16. *Bucculatrix trifasciella* Clem. The larva *probably* feeds on it.
17. *Tischeria castaneæcella* Chamb. Larva mines the upper surface of the leaves.
18. *Nepticula castaneæfoliella* Chamb. Larva in crooked, linear mines in the upper surface.

INSECTS INJURIOUS TO THE LOCUST.

(Robinia pseudacacia.)

AFFECTING THE TRUNK.

1. THE LOCUST BORER.

Cyllene picta (Drury).

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring a hole $\frac{1}{4}$ inch in diameter under the bark and upwards, deep into the wood, and ejecting the dust through the orifice in the bark, a longicorn larva, which transforms to a pupa in its burrow, and late in summer appears as a brown beetle, striped and banded with golden yellow, and with a **W** on its wing-covers; often abundant on the flowers of the golden rod early in September, when they lay their eggs in crevices in the bark of the locust.

This is by far the most destructive pest of the locust, one of the most beautiful and valuable of our shade trees. In New England there is scarcely a tree which does not show the marks of its attacks, and in many localities it has practically been exterminated. In the Western States it is also very destructive; but from observations we have made in Kentucky the noble locust trees in that State grow so luxuriously as to apparently escape or overcome the insidious attacks of this borer. It occurs throughout the United States east of the Plains.

The operations of the grub or larva may be detected by a mass of sawdust-like castings at the mouth of its gallery.

The beetles are abundant, feeding on the flowers of the golden rod (*Solidago*), early in September, when we have taken them in Cambridge, Mass., and Providence, R. I. So wide are the deep yellow spots and bands that the beetle is nearly all of the shade of deep golden yellow peculiar to the flowers of the golden rod, and thus the insect is an interesting case of "protective mimicry," being protected from the attacks of birds, &c., by its liability to be confounded with the yellow heads of the golden rod.

The best account of these insects has been given, as follows, by Harris:

In the month of September these beetles gather on the locust-trees, where they may be seen glittering in the sunbeams with their gorgeous livery of black velvet and gold, coursing up and down the trunks in pursuit of their mates, or to drive away their rivals, and stopping every now and then to salute those they meet with a rapid bowing of the shoulders, accompanied by a creaking sound, indicative of recognition or defiance. Having paired, the female, attended by her partner, creeps over the bark, searching the crevices with her antennæ, and dropping therein her snow-white eggs, in clusters of seven or eight together, and at intervals of five or six minutes, till her whole stock is safely stored. The eggs are soon hatched, and the grubs immediately burrow into the bark, devouring the soft inner substance that suffices for their nourishment till the approach of winter, during which they remain at rest in a torpid state. In the spring they bore through the sap-wood more or less deeply into the trunk, the general course of their winding and irregular passages being in an upward direction

from the place of their entrance. For a time they cast their chips out of their holes as fast as they are made, but after awhile the passage becomes clogged and the burrow more or less filled with the coarse and fibrous fragments of wood, to get rid of which the grubs are often obliged to open new holes through the bark. The seat of their operations is known by the oozing of the sap and the dropping of the sawdust from the holes. The bark around the part attacked begins to swell, and in a few years the trunk and limbs will become disfigured and weakened by large porous tumors, caused by the efforts of the trees to repair the injuries they have suffered. According to the observations of General H. A. S. Dearborn, who has given an excellent account* of this insect, the grubs attain their full size by the 20th of July, soon become pupæ, and are changed to beetles and leave the trees early in September. Thus the existence of this species is limited to one year.

As is well known, this species also attacks the walnut and hickory, and occasionally the honey-locust, but those individuals living in these trees, unlike the locust brood, evolve the beetle in June, according to Walsh, who has claimed that the males of the hickory-brood differ from those of the locust-brood in having "much longer and stouter legs and much longer and stouter antennæ, and in having [their bodies] tapered behind to a blunt point"; on the other hand the females are not distinguishable, nor the larvæ. On this account Mr. Walsh regarded the locust and hickory broods as representing two distinct species, a view not now entertained. He gives, however, some interesting facts in the *Practical Entomologist*, vol. i, p. 29, regarding the appearance of this insect in the Western States, as follows:

The history of this species is very curious, and as it has only recently been elucidated by myself, and some additional details can now be added, may be briefly summed up as follows: About a hundred years ago this insect was well known to Forster to inhabit the locust in the State of New York. Twenty years ago, although the best Illinois botanists agree that the locust grows wild in the Southern part of Illinois, it was still unknown in that State. Shortly afterwards it commenced attacking the locusts in the neighborhood of Chicago, and thence spread gradually in a south-south-west and west direction through the State, sweeping the locusts before it wherever it came. In 1860, it had pretty well destroyed all these trees in Central Illinois. Rock Island lies on the Mississippi River 180 miles south of west from Chicago. In 1862 it had reached a point 20 miles east of Rock Island. In 1863 it burst forth suddenly in great swarms from all the locusts in Rock Island, and the two following years about completed their destruction. It has now (1865) crossed the river into Iowa, and no doubt will continue its travels westward as long as it finds any locust trees to prey on.

Lest it should be supposed that, agreeably to the belief of all the older writers, the species that inhabit the hickory is identical with that which inhabits the locust, it is proper to add here, that I myself split the hickory insect out of a stick of hickory wood, as much as eight years ago in Rock Island; that abundance of hickory grows in the woods within half a mile of that city, and yet that our locust trees were never attacked by borers until 1863, when they were suddenly attacked in the manner mentioned above. Professor Sheldon, of Davenport, Iowa, has also repeatedly, for many years before 1863, split the hickory insect out of hickory wood in Davenport, although,

* Dr. Horn, who has observed this borer in the hickory, states (Proc. Ent. Soc. Phil., i, 30) that its excavations are immediately subcortical. "Unlike the *Clytus erythrocephalus*, which also bores in the hickory, its course is not in a line, but it bores in every direction, making extensive excavations. Its borings are coarse and sawdust-like, and are packed with considerable firmness. When about to become a pupa the larva bores for a slight depth into the wood, and for a distance of about three inches. The aperture is closed with some very coarse splinter-like borings, and after having turned its head in the direction of its previous subcortical dwelling, it undergoes its transformation, and requires about two and sometimes three weeks for becoming a perfect insect."

so far as he is aware, the locusts in Davenport had not been attacked by borers up to 1863. Now, if the hickory-borer is identical with the locust-borer, why did it not attack the locusts in Rock Island and Davenport before 1863 and 1864? And why, when it did attack them, did it appear suddenly in great swarms?

The larva is six or seven-tenths of an inch long, somewhat flattened, club-shaped, the thoracic segments being considerably broader than the abdominal ones, but at the same time distinctly flattened above and below. The head when extracted from the thorax appears almost circular and narrower than the prothorax. The latter is twice broader than long, rounded anteriorly, flattened above and below, brownish yellow, covered, especially on the sides and below, with a short golden pubescence. A deep longitudinal sinuated furrow is visible on each side, a short transverse furrow crosses its posterior end. The upper disk is inclosed between two furrows beginning at the posterior margin, and not reaching the anterior one; a transverse furrow, parallel to the posterior margin, separates a narrow fleshy fold. The anterior portion of this upper disk is irregularly punctured and wrinkled, although shining; in some specimens it has an indistinct, elongated, somewhat oblique brownish spot on each side, about the middle; the posterior portion of the disk is opaque, covered with dense longitudinal wrinkles, among which a straight impressed line is apparent in the middle. The ventral side is irregularly punctured on the sides, and has a depression in the middle which is less apparent in some specimens.

The other two thoracic as well as the two first abdominal segments have, above and below, a transverse flattened opaque disk, limited on each side by a furrow, and showing some indistinct furrows on its surface; the other abdominal segments have the usual protuberances, on the dorsal as well as the ventral side, marked with wrinkles. The last segment is short and divided in two halves by a transverse fold; the latter half has the anal opening at the tip. All these segments are beset with short golden hairs on the sides. There are no feet, as in the *Lamii*. (Ostensacken.)

The pupa has numerous pointed granulations on the prothorax; similar granulations ending in sharp points are placed in a row on the dorsal segments of the abdomen, near the posterior margin; the same segments have, more anteriorly, a few similar sharp, horny projections. On the penultimate segments these projections are larger and recurved anteriorly at the tip; there are six in a row near the posterior margin, and two others more anteriorly. The last segment has four similar projections in a row. (Ostensacken.)

The beetle.—Body velvet-black, and ornamented with transverse yellow bands, of which there are three on the head, four on the thorax, and six on the wing-covers, the tips of which are also edged with yellow. The first and second bands on each wing-cover are nearly straight; the third band forms a "V," or, united with the opposite one, a "W," the fourth is also angled, and runs upwards on the inner margin of the wing-cover towards the scutel; the fifth is broken or interrupted by a longitudinal elevated line; and the sixth is arched, and consists of three little spots. The antennæ are dark brown, and the legs are rust-red. These insects vary from six-tenths to three-fourths of an inch in length. (Harris.)

Remedies.—An excellent way to save a valuable shade tree from the attacks of this borer is to thoroughly soap the trunk late in August, so as to prevent the beetle from laying its eggs early in September. All insects breathe through little holes (twenty in all, ten on each side); now, if a film of soap or grease or oil of any kind closes the openings of these breathing pores, the air cannot enter the respiratory tubes which ramify throughout the interior of the body and the insect dies by asphyxiation—i. e., drowns. Harris states that whitewashing and covering the trunks of the trees with grafting composition may prevent the female from depositing her eggs upon isolated trees. Also, young

trees might be headed down to the ground, so as to destroy the grubs boring in them, and also to promote a more vigorous growth. An excellent preventive remedy is to collect these beetles early in September when engaged in eating the flowers of the golden rod; children could perform this labor.

AFFECTING THE LEAVES.

2. THE LOCUST DEPRESSARIA.

Depressaria robiniella Packard.

Order LEPIDOPTERA; family TINEIDÆ.

Occasionally late in June defoliating the branches, a small green larva with a thick body, black head, and transforming late in July to a light brick-red moth, spotted irregularly with yellow.

The following account of this destructive moth is taken from our "Guide to the Study of Insects." The moths of the Tineid genus *Depressaria* comprise rather large species, in which the fore wings are unusually hard and oblong. The abdomen is flattened above, with projecting scales at the sides. The larvæ are extremely active and feed on a variety of substances; some in rolled-up leaves of composite plants, some in the leaves and others in the umbels of the umbelliferous plants. Many of the worms descend from the plant on the slightest agitation, so that considerable caution is necessary in attempts to collect them. The full-fed larvæ descend to the ground and change to pupæ among the fallen leaves. The perfect insects have the peculiarity of sliding about when laid on their backs.

During the summer of 1868 a large locust tree overhanging our garden in Salem, Mass., was attacked by the present species to such an extent that some of the branches were nearly stripped of their leaves. This moth we described under the name of *Depressaria robiniella* (Guide to Study of Insects, Pl. 8, fig. 14). The larva is thick-bodied, with a black head, and is green, the cervical shield being green. It devours the leaves, drawing them together by threads, and it also eats the flower buds. It was most abundant in the last week of June. It turned to a chrysalis July 8, and in about two weeks the moth appeared.

The moth.—The head, palpi, and fore wings are light brick-red, spotted irregularly with yellow, and the antennæ are slate-brown. The fore wings are a little darker in the middle, especially towards the inner edge. There is a submarginal darker brown band near the outer edge, which does not reach the costa, and on the outer edge is a row of minute black dots. The hind wings and abdomen are of a pale slate-gray, and of the same color beneath, while the legs are of a very pale straw-yellow. It differs from most of the species of the genus in having the apex of the fore wings less rounded than usual, and in this and other respects it is allied to the European *D. laterella*.

3. THE LOCUST LEAF-MINER.

Parectopa robiniella (Fitch).

Order LEPIDOPTERA; family TINEIDÆ.

Mining the leaf in July, making a blotch on the upper surface of the leaf, with a number of lateral galleries running out from it, on each side, a flattened pale green

worm which passes the chrysalis state in the leaf, the latter falling to the ground, and the following June giving out a minute moth.

This is a common leaf-miner of the locust in the New England as well as the Middle States. Out of the seventeen leaflets which form the locust leaf, usually two or three and often more make the blotches. The mines are not tenanted, Clemens states, at the time the leaf is mined by *Lithocolletis robiniella* (Clem. Proc. Phil. Acad., 1860).

The larva makes a pale yellowish mine, usually on the midrib, with lateral branches running out from it. It pupates in a small nidus on some object on the ground.

The moth.—Fore wings fine brown, somewhat golden, shaded with dark brown. Along the costa are three oblique silvery streaks; on the inner margin are three silvery dorsal spots, placed opposite the spaces between the costal streaks. Near the tip of the wing is a transverse narrow curved silvery line, passing from the costa to the inner angle. (Clemens.)

4. THE GREATER LOCUST-LEAF GELECHIA.

Gelechia pseudacaciella Chambers.

Order LEPIDOPTERA ; family TINEIDÆ.

From eggs laid on the under surface of the leaf hatches a green larva with reddish head and thoracic plate and six longitudinal dusky stripes; spinning a slight web between two leaves; changing to a moth in late spring, whose wings expand 0.63 inch. It is sombre in color, the fore wings dark slate, flecked with brown and white; the hind wings pale slate, whitish towards the base.

5. THE LESSER LOCUST-LEAF GELECHIA.

Gelechia robiniaefoliella Chambers.

Spinning two locust leaves together and feeding between them, leaving the outer surface and the larger ribs untouched, a minute, greenish white slender larva, which transforms to a chrysalis in the same situation, the moth differing from its closely allied species in the palpi being slender and rather long, while the hind wings are emarginate beneath the apex. (Comstock and Chambers.)

6. THE AUTUMNAL LOCUST LEAF-MINER.

Lithocolletis robiniella Clemens.

Mining the underside of the locust-leaf late in September and early in October (in the Middle States) a cylindrical larva, with a pale brown head and the body greenish white, sometimes spotted with yellow; the chrysalis contained in a white silken cocoon within the mine, and transforming late in October and early in November into a minute moth with narrow pointed fore-wings, which are golden yellow along the costal edge and with a spot at the tip.

The species of *Lithocolletis* are known by their small size, the narrow, pointed fore wings, the tuft on the top of the head, and the simple, not ciliated antennæ. The larvæ mine the upper and under side of leaves and usually transform within a silken cocoon in their burrows. The present species is one of the best known of the genus.

The larva.—Body cylindrical, the head pale brown; the body pale greenish white, with a red median dorsal line from the 5th to the 9th segment; on the 9th segment are two irregular chrome-yellow patches, which are sometimes wanting. (Clemens.)

The moth.—Antennæ dark brown; front of head silvery white, the tuft dark brown

mixed with grayish; thorax dark brown; fore wings golden yellow above the fold, and dark cinereous, somewhat dusted with blackish beneath it. About the middle of the wing is an oblique silvery costal streak, black-margined on both sides, extending to the fold; another beyond the middle, meeting nearly in the center of the wing at an angle, a dorsal streak from the inner margin, the former black-margined on both sides, extending to the fold; another beyond the middle, meeting nearly in the center of the wing at an angle; a dorsal streak from the inner margin, the former black-margined on both sides, the latter internally; another costal streak near the tip with an internal circular black margin opposite to a dorsal streak of the same hue, and joined or nearly joined to it. Just behind the apical spot is a straight silvery streak, black-margined internally. A black round spot at the tip of the fore wings. Hind wings shining dark gray. (Clemens.)

7. THE LOCUST SKIPPER BUTTERFLY.

Eudamus tityrus Fabricius.

Drawing the leaves together in July, a large pale green caterpillar about 2 inches long, with a red neck and large red head, with a large yellow spot on each side of the mouth, feeding by night, sometimes pupating between the leaves, and transforming into a stout-bodied, brown butterfly with a skipping, rapid, strong, low flight, and antennæ flattened and bent over at the end. (Harris.)

These voracious worms sometimes strip the leaves of the common locust and especially the viscid locust (*Robinia viscosa*), which is cultivated in New England as an ornamental tree. According to Harris, the females lay their eggs singly during June or early in July on the leaves, the caterpillars hatch in July, and when quite small conceal themselves under a fold of the edge of a leaf, which is bent over their bodies and secured by means of silken threads. When they become larger they attach two or more leaves together, so as to form a kind of cocoon or leafy case to shelter them from the weather, and to screen them from the prying eyes of birds. One end of the leafy case is left open, and from this the insect comes forth to feed. They transform to chrysalids either among the leaves or desert the tree and seek some retired place, where they spin a slight loose cocoon, within which they remain through the winter, appearing in the imago state by the middle of the following June.

The butterfly is brown, the fore wings are brown with a transverse semi-transparent band across the middle, and a few spots towards the tip of a honey-yellow color; hind wings with a short rounded tail on the hind angles, and a broad silvery band across the middle of the under side. The wings expand from 2 to 2½ inches. (Harris.)

Remedies.—Nearly all the insects which prey upon the foliage of the locust can be gotten rid of by hand-picking and by collecting the leaves in autumn and burning them; in this way cherished shade trees can be protected.

8. THE LOCUST HISPA.

Odontota scutellaris (Olivier). *Hispa suturalis* Harris.

Order COLEOPTERA; family CHRYSOMELIDÆ.

In July, blister-like spots appearing upon the leaves, within which is a small flattened, whitish worm, with three pairs of feet; a quarter of an inch long, tapering

from before backwards, with projections along each side like the teeth of a saw; remaining a week in the pupa state within the leaf, about the middle of August it issues as a small flattened black beetle with the prothorax and wing-covers, except along their suture, tawny yellow. (Fitch & Harris.)

Harris states that in Massachusetts these beetles may be observed the middle of June pairing and laying eggs on the leaves of the locust tree.

While this species of leaf-mining beetle is met with in the New England States and New York, by information received from Kentucky it is at times quite injurious to locust trees in that State, but can always be kept under by hand-picking.



FIG. 42.—Locust Hispa.—From Packard.

9. SAY'S WEEVIL.

Apion rostrum Say.

Order COLEOPTERA; family CURCULIONIDÆ.

From June until September, eating numerous small round holes in the leaves, a little black weevil with a slender projecting beak, its thorax with close coarse punctures and an oval or longitudinal indentation back of its center, and the furrows of its wing-covers with coarse punctures; its length 0.09, and to the end of the beak 0.12 inch. (Fitch.)

Dr. Harris states that the grubs of this little weevil live in the pods of the common wild indigo bush (*Baptisia tinctoria*), devouring the seeds. He adds, "A smaller kind, somewhat like it, inhabits the pods and eats the seeds of the locust-tree, or *Robinia pseudacacia*." Fitch regards the insect as very variable, and as most probably destructive to the seeds of both the plants here mentioned.



FIG. 43.—Say's weevil.—From Packard.

10. THE BLACK LOCUST MIDGE.

Cecidomyia pseudacaciae Fitch.

Order DIPTERA; family CECIDOMYIADÆ.

In July and August, the tender young leaflets near the tip of the stem folded together like a little pod, the cavity inside containing from one to three small milk-white maggots, which descend below the surface of the ground, remaining there in the pupa state about ten days, and then appearing as a small blackish midge. (Fitch.)

According to Fitch, before the small young leaflets, which put forth along the opposite sides of the main leaf-stalks at their tips become expanded, they are closed together like two leaves of a book; and it is probably at this time that the female midge inserts her egg in the cleft between them, the irritation from which and from the small maggots which hatch from them, keeps the leaflet permanently closed; a slight cavity forming within, in which the worms reside, the leaflet hereby comes to resemble in its shape a small bivalve shell with a more or less wavy edge. The surface remains unchanged outside, but within it assumes a pale greenish yellow color. The attachment of the leaflets to the stalk becomes so weakened when infested by these worms that prob-

ably they are generally broken off by the wind, and the worms are thus carried to the ground, instead of crawling down the stalks by night, as is the habit of the wheat midge.

The female.—A small blackish midge, the base of its thorax tawny yellow, its abdomen pale yellowish with the tip dusky and clothed with fine hairs, as is also the neck; its legs black with the thighs pale except at their tips; its wings dusky, feebly hyaline, with the fringe short; its antennæ with thirteen short cylindrical joints separated by short pedicels; its length 0.065 inch to the tip of the body.

11. THE YELLOW LOCUST MIDGE.

Cecidomyia robinia Haldeman.

Order DIPTERA; family CECIDOMYIADÆ.

In July and August a portion of the edges of the leaves rolled inwards on their under sides and thickened, inclosing one or two very small white maggots which are varied more or less with orange-yellow; producing a pale orange midge with the sides of its thorax and often three oval stripes on the back and the wings dusky; its antennæ blackish and of fourteen joints in the females, twenty-four in the males; its length 0.12 inch. (Fitch and Haldeman.)

Professor Haldeman, who described this two-winged gall fly in Emmon's Journal of Agriculture and Science, October, 1847, says that it, in conjunction with the *Hispa* already mentioned, had been so numerous in southeastern Pennsylvania the two preceding summers as to kill the leaves upon the locusts, the trees in August appearing as though they had been destroyed by dry weather.

This insect may be detected by the margin of the leaflets being rolled inwards upon their under sides for a length varying from over a quarter to a half inch, the upper side showing a concavity or rounded hollow at this point. "This rolled portion," says Fitch, "is changed in its color to a paler yellowish green, and its texture is thickened and succulent." The same leaf sometimes has two or more of these folds along different parts of its margin.

The larva is colorless or watery when young, becoming, as it approaches maturity, opaque and milk white, varied more or less with bright yellow. It is long oval, broadest in the middle and tapering thence to a sharp point anteriorly, the opposite end being bluntly rounded, and is divided into thirteen segments by transverse impressed lines. (Haldeman.)

12. THE LOCUST SAW-FLY.

Nematus similis Norton.

Order HYMENOPTERA; family TENTHREDINIDÆ.

Eating the leaves of the black locust, a small, soft, green worm $\frac{3}{4}$ inch long, with 20 legs, and a brownish head; appearing in Washington, D. C., late in August until October; transforming in a dark-brown oval cocoon, and two or three weeks later issuing as a saw-fly nearly $\frac{1}{2}$ inch long, of a dirty yellow color, with a squarish black patch on top of the head, the sides and front of the thorax black, and a transverse band on top of each abdominal segment. (Comstock.)

This saw-fly inserts its irregularly semi-ellipsoid eggs in a crescent-shaped cut made in the under surface of the leaf by the "saw." In a

few days the larva hatches. Professor Comstock thinks there are two and possibly three broods in a season, and that the insect may hibernate both in the adult and pupa stages.

The following insects also feed on the locust:

13. *Spermophagus robiniae* (Fabricius). Family *Bruchidae* (see Horn, Trans. Amer. Ent. Soc., iv, 311).
14. *Scapteron robiniae* H. Edwards. (Destructive to locusts in Virginia City, Nevada. Bull. Brooklyn Ent. Soc., iii, 72.)
15. The Io moth, *Hyperchiria io* (Fabricius). (See p. 111.)
16. The hickory tussock moth, *Orgyia leucostigma*.
17. The locust goat moth, *Xyleutes robiniae*, which more commonly affects the oak. (See p. 6.)
18. *Clisiocampa erosa* Stretch. Oregon. (Papilio, i, 67.)
19. *Gelechia pseudacaciella* Chamb. Larva feeds externally on the leaves and also in the mines of *Lithocolletis robiniella* (Chambers).
20. *Xylesthia clemensella* Chamb. Larva bores in dead locust-timber posts, etc. (Chambers.)



FIG. 44.—Locust saw-fly. a, eggs; b, c, worms; d, tail of the same; e, cocoon; f, fly.—After Comstock.

INSECTS INJURIOUS TO THE MAPLE.

(*Acer saccharinum* and *Acer rubrum*.)

1. THE SUGAR-MAPLE BORER.

Glycobius speciosus (Say).

Boring into the solid trunks of healthy sugar-maple trees, often killing them, a rather large, footless, cylindrical, whitish grub, changing in July to a large, beautiful, yellow-striped beetle, marked with a golden W on the wing-covers.

Although the question as to whether longicorn larvæ will bore into healthy solid wood is by some regarded as undecided, there is no doubt but that the present larva bores for several inches into the trunks of healthy trees, both young maples as well as trees ten or twenty inches in diameter. The following case fell under our own observation. On the grounds of Bowdoin College, Brunswick, Me., for two successive years (1873-'74) a number of fine sugar or rock maples, nearly a foot in

diameter, and which had been set out for thirty or forty years, suddenly died, and on being cut up into fire-wood were found to be deeply perforated in all directions by larvæ referable to this species by its large size and resemblance to the locust borer. More than one larva and one burrow were found in the same tree. There seemed little cause to doubt but that the grubs were the cause of the sudden death of the tree.

In the summer of 1881, I noticed that one tree in the College Campus was partly killed by these borers, and that other trees in different parts of the town had been bored by them. One tree, over one foot in thickness, had about twelve holes in the trunk, from which the beetles had issued a year or two previous. The leaves during the past summer were small and curled up, and the tree was evidently in a sickly condition. The few *Aphides* and *Psoci*, observable on the leaves in July and August, were not sufficiently numerous to occasion the trouble, and we attribute it to the effects of the borer. Another somewhat larger sugar maple in the same yard, the age of which was about forty-five years, had but two holes in it, made by the same borer, probably in 1878 or 1879; the tree was nearly healthy, with fully developed leaves. A red maple close at hand had not been affected by the borer, and we could not learn that this species (*A. rubrum*) had ever been attacked by this borer. It seems to us that these are clearly demonstrated cases, where healthy trees have been killed by borers.

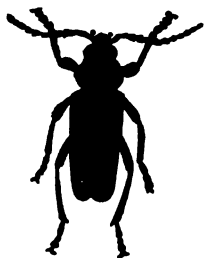


FIG. 45.—*Glycobius speciosus*. Natural size.
—From Saunders.

The first observer to notice this borer, and the fact that it destroys living maples, was Rev. L. W. Leonard, who gave an account of its habits to Harris. His attention was called, in 1828, to some young maples in Keene, N. H., which were in a dying condition. He discovered the insect in its beetle state under the loosened bark of one of the trees, and traced the recent track of the larva three inches into the solid wood. In the course of a few years these trees, upon the cultivation of which much care had been bestowed, were nearly destroyed by the borers.

This beetle was said by Mr. E. B. Reed, in 1872, to be gradually destroying the sugar maples at London, Canada, and in the Report of the Entomological Society of Ontario, for 1878, Mr. Saunders states that the destruction was spreading rapidly in the streets of the same city. To this society we are indebted for the use of the figure of the beetle.

The beetle, according to Harris, lays her eggs on the trunk of the maple in July and August. The grubs burrow into the bark as soon as they are hatched, and are thus protected during the winter. In the spring they penetrate deeper, and form, in the course of the summer, long and winding galleries in the wood, up and down the trunk.

The beetle is black with a yellow head, with the antennæ and the eyes reddish black; the thorax is black, with two transverse yellow spots on each side; the wing-

covers for about two-thirds of their length are black, the remaining third is yellow, and they are ornamented with bands and spots arranged in the following manner: a yellow spot on each shoulder, a broad, yellow, curved band or arch, of which the yellow scutellum forms the keystone on the base of the wing-covers, behind this a zigzag yellow band forming the letter W, across the middle another yellow band arching backwards, and on the yellow tip a black curved band and spot; legs yellow, while the under side of the body is reddish yellow, variegated with brown. Nearly an inch in length. (Harris.)

Remedies.—This, like some similar borers, should be looked for in the spring, when it can be detected by the dust it casts out of its burrow, and when it can be cut out of the tree with a knife, or killed by inserting a stiff wire, or by the injection of kerosene oil into the hole.

2. THE HORN-TAIL BORER.

Tremex columba (Linnaeus).

Order HYMENOPTERA; family UROCEIDÆ.

Boring in the trunk and making large round holes, a large white grub, with a prominent spine on the end of the body, and transforming in the late summer into a large clear-winged saw-fly, with a long, large "saw" on the tail of the female.

This interesting insect bores indifferently in various forest and shade trees, attacking the elm, oak, sycamore, and perhaps more commonly the maple. The holes of this borer may be recognized by their large numbers within a given space, and by their regular, evenly-cut shape, being about the diameter of a lead-pencil. We remember seeing some years ago a tree at Saratoga Springs, in the trunk of which, where the bark had been removed, were a dozen or more of the round, even holes made by these insects, who seem to work somewhat in concert. Isolated shade-trees along roads and in streets are favorite places of resort. Harris says that an old elm tree in his vicinity used to be a favorite place of resort for this saw-fly, numbers of them collecting about it during the months of July, August, and the early part of September. "Six or more females might frequently be seen at once upon it, employed in boring into the trunk and laying their eggs, while swarms of the males hovered around them. For fifteen years or more some large buttonwood trees in Cambridge have been visited by them in the same way. The female, when about to lay her eggs, draws her borer out of its sheath, till it stands perpendicularly under the middle of her body, when she plunges it, by repeated wriggling motions, through the bark into the wood. When the hole is made deep enough, she then drops an egg therein, conducting it to the place by means of the two furrowed pieces of the sheath. The borer often pierces the bark and wood to the depth of half an inch or more, and is sometimes driven in so tightly that the insect cannot draw it out again, but remains fastened to the tree till she dies. The eggs are oblong-oval, pointed at each end, and rather less than one-twentieth of an inch in length." Harris adds, what has been observed frequently by others since his time, that these larvæ

are often destroyed by the maggots or larvæ of two singular ichneumon flies (*Rhyssa atrata* and *lunator*). These are the largest known ichneumon flies; they are provided with long, slender borers or ovipositors from three to four inches in length, which they thrust into the deep holes made by the Tremex borers, in the bodies of which they insert an egg.

(We have, however, observed one of these *Rhyssa* engaged in ovipositing in an elm tree infested with the larvæ of *Compsidea tridentata*.)

The following description of the larva is copied from our report "On the Insects affecting the Cranberry, with remarks on other injurious Insects."*

The larva.—A long, white, cylindrical worm, with the segment behind the head of the same width as the twelfth segment from the head; the thirteenth much narrower, regularly rounded behind, with a deep crease above, leading backward and a little downward to a small, sharp, terminal, dark-reddish horn. The horn is acute, with three teeth above, near the base, and two smaller ones on the under side. Each of the three last rings bulges out on the under side. The head is white, and about half as wide as the segment behind, into which it partially sinks. It is rounded, smooth, with the antennæ represented by small rounded tubercles, ending in a minute horny spine; should the spine be regarded as indicating a joint, then the appendage is three-jointed. The clypeus is broader than the labrum by a distance equal to its own length. The labrum is a little more than twice as broad as long, with the front edge slightly sinuous. The large, powerful mandibles are four-toothed on one side and three-toothed on the other. The maxillæ are three-lobed, the lobes unequal, ending in spines, the middle lobe with two spines, the outer lobe much smaller than the others. The labium or under lip is rather large, rounded, with a spine projecting on each side. The pro-

FIG. 46.—
Larva of
Tremex
columba,
nat. size.
—From
Packard.

thorax or segment next behind the head is twice as long as the one behind it, divided into two portions by a suture behind it. There are three pairs of small, soft, unjointed feet, of which the first pair are considerably the largest; they do not project straight out but are pressed to the body and directed backward. There are ten pairs of spiracles, one pair on the hinder edge of the prothorax, twice as large as the others; the second pair between the second and third rings, and the eight others on the eight basal abdominal segments. Length, 2.25 inches; greatest thickness, .28 inch.

The larvæ from which the above description was taken were found at Amherst, Mass., early in October, in a tree containing several of the adult insects, which had not left their holes and seemed likely to be destined to pass the winter in the tree. Clementi has in Ontario, Canada, taken several of the imago with the larvæ from the oak in March, so that it undoubtedly hibernates as an imago.

3. THE SIXTEEN-LEGGED MAPLE-BORER.

Egeria acerni (Clemens).

Order LEPIDOPTERA; family EGERIADÆ.

Following the work of the flat-headed borer, burrowing under the bark of the soft maple, sometimes girdling and killing the tree, a caterpillar with sixteen legs, spin-

* In the Tenth Annual Report of the U. S. Geological and Geographical Survey of the Territories. By F. V. Hayden, U. S. Geologist. Washington, 1878.

ning a cocoon of silk covered with its castings; the moths issuing from the tree late in May and thence through the summer, the worms occurring under the bark through the summer and winter. (Riley.)

This borer is sometimes very destructive to soft and sometimes to sugar maples, especially young trees, in Ohio, Illinois, and Missouri, the moths sometimes emerging in great numbers from the trunks of the trees. Mr. G. R. Pilate states that the red maple trees in Dayton, Ohio, were greatly infested by this borer, in consequence of which a large number of those shade trees are dead or dying. (Bull. Brooklyn Ent. Club, vol. i, 20.) Mr. Riley says he has always found the worms in such trees as have been injured either by the work of the flat-headed borer, by the rubbing of the trees against a post or board or in some other way. "Where the bark is kept smooth they never seem to trouble it, the parent evidently preferring to consign her eggs to cracked or roughened parts. For this reason the worm is not found in the smoother branches, but solely in the main trunk. Whether the soap applica-

 FIG. 47.—*Aegeria aceris*; a, caterpillar; b, cocoon; c, pupa cases —After Riley.

 tions will prevent the moth from depositing her eggs is not known; judging from analogy, probably not. Yet it will tend to keep the bark smoother, and in being used to shield the tree from the other borer, it will indirectly shield it from this one. Mr. Gennadius recommends whitewashing the trunks, and filling up all holes and fissures with mortar, so as to render the bark as smooth as possible."

The moth.—Head and palpi deep, reddish orange, thorax ochreous yellow; abdomen bluish black varied with yellow, with a deep reddish terminal tuft. Fore wings with the edges and median vein bluish black dusted with yellowish; a large discal bluish black patch; end of the wing ochreous yellow, with a blackish subterminal band, and the veins blackish. Hind wings with a blackish discal patch. Body beneath ochreous yellow, with a bluish black patch on each side of the second abdominal segment. Middle and posterior tibiae ringed with bluish black; the fore legs blackish, with the coxae (or hip joints) touched with reddish orange; expanse of wings about 0.80 inch.

The larva is a little over half an inch long, livid white, the head small and yellow, with 16 legs, all of which are reddish. (Clemens.)

4. THE FLAT-HEADED APPLE-TREE BORER.

Chrysobothris femorata Fabricius.

In the Mississippi Valley, sometimes riddling soft maples through and through, confining itself mostly to the inner bark, causing peculiar black scars and holes in the trunk, a flat-headed grub, transforming to a flat, hard-shelled beetle. (Riley.)

While this beetle more commonly infests the oak (p. 16) and the apple, it threatens in the Western States, according to Riley, to impair the value of the soft maple for shade and ornamental purposes.

5. THE PEACH AND CHERRY FLAT-HEADED BORER.

Dicerca divaricata Say.

Order COLEOPTERA; family BUPRESTIDÆ.

Boring in red maple stumps a flat-headed borer whose prothoracic segment is not so wide in proportion to the two following segments as in *Chrysobothris* larvæ.

Although Fitch says that the beech is undoubtedly the original residence of this borer, now destructive to cherry and peach trees, and that "wherever a dead tree of this kind occurs some of these beetles will almost always be found upon it on sunny days in midsummer," we have found several of the fully and half-grown larvæ, with the dead beetle, in a partly rotten stump of the swamp maple at Providence, June 1. The hole for the exit of the beetle is oval cylindrical, 8^{mm} in its longer diameter and 4^{mm} in its shorter. The following description of the larva was drawn up from the larger specimens; that of the beetle is quoted from Harris:

Larva.—Prothoracic segment moderately broad, not so long as wide, but not so wide in proportion to the two succeeding segments as in *Chrysobothris*; the second thoracic segment trapezoidal, narrower than the first by two-thirds of its length; third thoracic segment a little narrower and a little longer than the second. All the abdominal segments about two-thirds as wide as the third thoracic, and round and thick. The terminal segment a little over one-half as wide as the one before it. Prothoracic segment with a large broad rough chitinous surface, with an inverted narrow V with long slender arms to the V. On the under side of the segment the rough surface is divided into two by two nearly parallel, longitudinal smooth lines. Length of body, 35^{mm}; length of prothoracic segment, 5^{mm}; breadth, 7^{mm}; width of metathoracic segment, 5^{mm}; width of an average abdominal segment, 4^{mm}.

The beetle.—Wing-covers much elongated and spreading widely apart at the end; the insect copper-colored, thickly covered with little punctures; the prothorax slightly furrowed in the middle; the wing-covers marked with numerous fine irregular impressed lines and small oblong square elevated black spots; middle of the breast furrowed; the male with a little tooth on the under side of the shanks of the middle pair of legs. Length, 18^{mm}–23^{mm}.

6. THE QUERCITRON BARK BORER.

Graphisurus fasciatus (De Geer).

Order COLEOPTERA; family CERAMBYCIDÆ.

This beetle, more commonly found on the oak, has been found in the pupa as well as adult stage under the bark of the sugar maple in Northern New York by Mr. George Hunt; and we have reared the beetle from a pupa found under the bark of the red or swamp maple, at Providence, June 1. The cell made by the larva for the repose of the pupa is about an inch long, one-third of an inch wide, and one tenth deep. (See, also, p. 22.)

7. *Xyloterus politus* Say.

Order COLEOPTERA; family SCOLYTIDÆ.

In this species, according to Leconte, the elytra have ill-defined distant rows of punctures, with interspaces equally strongly punctured,

pubescence erect and abundant. He has received specimens from Mr. J. A. Lintner, said by him to depredate on maple trees. "It is easily known," adds Leconte, "by being more hairy than the other species, with the interspaces of the elytra sparsely punctured, so that the rows of punctures appear confused."

8. *Stenoscelis brevis* Boheman.

Order COLEOPTERA; family CALANDRIDÆ.

This beetle occurred in a partly rotten stump of the red maple in a swamp at Providence; June 1, in company with *Dicerca divaricata* and *Xestobium affine*. All these beetles were submitted to Dr. Leconte for identification. The mine is irregular, sinuous, 1.5–2^{mm} in diameter, and were quite numerous.

9. *Xestobium affine*.

Order COLEOPTERA; family PTINIDÆ.

Several specimens of this beetle occurred June 1 in a rotten stump, with the larvæ, which closely resembles those of *Ernobius*. It makes a sinuous mine 4^{mm} in diameter, and opening externally by a round hole 3^{mm} in diameter; the burrows being filled with fine excrement.

Larva.—Body cylindrical, white, soft, very full and rounded at the end, a little the thickest at the thoracic portion; 3 pairs of thoracic, 3-jointed rather slender feet. Head rather large, more than half as thick as the body. End of abdomen covered with rather dense yellowish hairs. Length, 10^{mm}; thickness of body, 3.1–4^{mm}. Fig. 441 of *Ernobius mollis* in my Guide to the Study of Insects well represents the general appearance of this larva.

AFFECTING THE LEAVES.

10. THE GREEN-STRIPED MAPLE WORM.

Anisota rubicunda (Fabricius).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Sometimes nearly stripping soft maples of their leaves, large smooth worms longitudinally striped with pale and darker green lines, and recognizable by two anteriorly-projecting black horns on the second segment behind the head, and transforming to a pale, ochre-yellowish, thick-bodied moth, tinged, especially on the fore wings, with a rosy hue, and expanding a little over two inches.

Although in the Eastern States this insect, especially the moth, is not common, yet we have observed it as far east as Brunswick, Me., where it feeds on the maple, the moth there appearing the middle of June; in the Western States, Illinois, Missouri, and Kansas, it proves during certain years very destructive, entirely or nearly stripping the soft or swamp and sometimes the silver maple of its leaves, and discouraging people from planting this tree along roadsides. It is known to feed on the oak.

According to Riley, the eggs are deposited in patches of thirty and upward, on the under side of a leaf. Each is about 0.05 inch long, sub-oval, slightly flattened, translucent, and pale greenish.

In Missouri and Kansas the worm is double-brooded, the first brood of worms appearing mostly during June and giving forth the moths late in July, while the second brood of worms appears in August and September, wintering in the chrysalis state, and not appearing as moths until the following May. The caterpillar molts four times, becoming fully fed within a month, and then entering the ground to pupate.

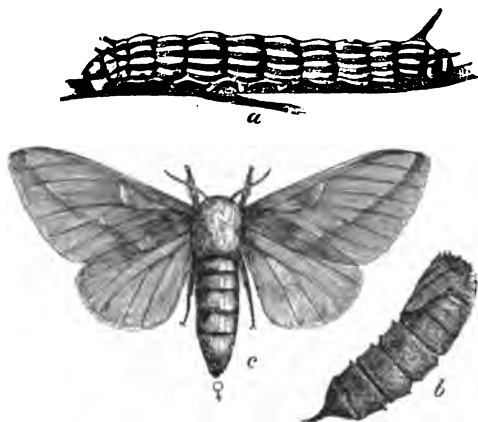


FIG. 48.—The rosy forest caterpillar. *b*, pupa; *c*, female. —After Riley.

nearly uniform size. In the *second stage* the head is browner, and the spines and stripe of the full-fed larva more apparent. In the *third stage* like the caterpillar in its fourth or last stage, but smaller. The *fully-fed caterpillar* is an inch and a half long; pale yellowish-green longitudinally, striped above alternately with eight very light yellowish-green lines and seven of a darker green, inclining to black, with two slender black spines on the second segment behind the head, and two lateral rows of sharper, shorter spines. Head copal yellow; segments, 10 and 11 a little dilated and rose colored at the sides.

The chrysalis.—Rough and pitted, nearly black, with curved horns about the head and thorax, and the movable joints provided with a ring of sharp conical teeth around the anterior edge. (Riley.)

The moth.—Fore wings rose-colored, crossed by a broad pale-yellow band; the hind wings pale yellow, with a short rosy band behind the middle; the body is yellow, the under side and legs rose-colored (Harris). In Western specimens, the yellow predominates, the rose-color being but faintly visible, according to Riley, who has also had specimens which were almost white or colorless. The wings expand about two inches. The male antennæ are broadly pectinated like feathers.

Remedies.—A tachina parasite, *Tachina (Belvosia) bifasciata* Fabr., and an ichneumon fly prey upon the caterpillars, and thus reduce their numbers. Riley recommends searching for and destroying the moths and eggs late in May, while the worms, when about to leave the trees, "may be entrapped by digging a trench either around the individual tree or around a grove or belt. The trench should be at least a foot deep, with the outer wall slanting under. Great numbers of worms will collect in it, or bury themselves in its bottom, and may easily be killed."

11. THE GREEN STINGING IO CATERPILLAR.

Hyperchiria io (Fabricius).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Sometimes feeding late in summer on the maple, a large, greenish, thick caterpillar, with fascicles of irritant, radiating, sharp spines over the body, spinning a thin silken

cocoon among the leaves, and transforming the following May or June into a large, stout-bodied moth; the males yellow with a very large eye-like spot on the hind wings, and the females purple-brown, the wings of the latter expanding nearly three inches

Although this large caterpillar is a general feeder, devouring in the Southern States the leaves of the Indian corn, as well as the sassafras, black locust, the false indigo, wild black cherry (*Prunus serotina*), and the willow, currant, cotton, clover, elm, hop vine, balsam, poplar, balm of Gilead, dogwood, and choke cherry, we have found it in

Maine, where it is a rare moth, feeding on the rock or sugar maple, and hence refer to it under this head. The eggs are top-shaped, attached by the smaller end, in patches of about thirty, on the under side of leaves. The caterpillars



FIG. 49.—Green stinging caterpillar.—After Riley.

in the Western States begin to hatch about the end of June, getting their growth in two months, after molting five times. The spines are poisonous to the fingers and the caterpillar cannot be handled without causing some pain and irritation.



Fig. 50.—Male of io moth.—After Riley.

yellow marked with purple brown, with a large, round blue spot, bordered with black, with a central white dash. The fore wings of the female are purple brown, the hind wings as in the male. In Massachusetts the moths appear during June or early in July.

The larva.—About two inches long, of a pea-green color; the spreading, slender spines deeper yellow and often tipped with black. A lateral white line, edged above with lilac.

The moth.—Males deep ochre-

12. THE MAPLE DAGGER-MOTH.

Apatela americana Harris.

Order LEPIDOPTERA; family NOCTUIDÆ.

In September, a rather large greenish-yellow caterpillar, with long hairs ornamented with four pencils of long hairs, and a single pencil on the eleventh ring, spinning a dense cocoon under the bark or elsewhere, and transforming into a whitish moth the next summer.

This is not uncommon on maple trees late in the autumn, and its

habits are described by Harris, who says that it also feeds on the elm, linden, and chestnut. We have often noticed it in Maine.

13. FOREST TENT CATERPILLAR.

Clisiocampa sylvatica.

A colony of the worms not fully fed were found June 6, collected in a mass near the ground on the trunk of the maple at Brunswick, Me.; at this time they were molting for the last time.

14. THE MAPLE SLUG MOTH.

Lithacodes fasciola H. Sch.

Order LEPIDOPTERA; family BOMBYCIDÆ.

According to Clemens, the larva is elliptical, somewhat pointed behind; body thickest in the middle, flattened, with the sides curving from a central ridge; this ridge has a vertical elevation at its sides above the body, growing less and less before and behind, terminating in front in a rounded margin, and behind in an obtuse, short spine. The body is smooth, with no distinct spined papulæ, but the edges of the ridge and the outline of the body are thrown into sub-crenated folds.



Fig. 51.—Maple slug moth. — From Packard.

15. THE LESSER MAPLE SPAN-WORM.

Stegania pustularia Guenée.

Feeding on the leaves early in June, a bluish-green looper striped with whitish and yellowish, producing the moth in July. (Saunders.)

This is a common insect and has been raised by Mr. W. Saunders, who says that the caterpillar is full grown about the middle of June, enters the chrysalis state within a few days after, and produces the moth early in July. We have found it in the woods of Northern Maine in August, and it is common in August in the Northern and Western States.

The larva.—Body cylindrical, about $\frac{3}{4}$ inch long, head medium sized, rather flat in front, slightly bilobed, pale green. Body above bluish-green, with thickly set longitudinal stripes of whitish and yellowish. A double whitish dorsal line, with bordering lines of yellowish white, neither of which are unbroken, but are formed of a succession of short lines and dots. Below these, on each side, are two or three imperfect white lines, made up of short streaks, and much fainter than those bordering the dorsal line; spaces between the segments yellowish. The skin all over the body is much wrinkled and folded. (Saunders.)

The moth is exceedingly pretty and may be recognized by its white body and wings and four deep golden-ochreous costal spots, with two lines running across the wings, these lines sometimes wanting. It expands an inch.

16. THE LARGE MAPLE SPAN-WORM.

Eutrapela transversata Packard.

Feeding on red maple in July, a large slender-bodied span-worm, the body thickened behind, carinated on the sides; of a dark purple-brown mixed with reddish; a dorsal

reddish-gray crescent-shaped spot on the middle of the seventh segment, behind which is a pair of low kidney-shaped tubercles, and a pair of dorsal pointed black ones on the eleventh; second ring swollen on the sides. Length, crawling, 46^{mm}. Changes to a pupa the end of July in rolled leaf, the moth appearing August 10. (Goodell.) The moth is large, dull ochre-yellow, and the hind wings are tailed. We have taken it resting on red maple leaves in Maine.

17. THE AMERICAN SILK-WORM.

Teia polyphemus Hübner.

According to Mr. E. B. Reed, this insect "frequently attacks maples, and from the enormous size of the caterpillar and its voracious appetite a great deal of damage is often done." (Report Ontario Ent. Soc. for 1872, p. 39.)

18. THE CECROPIA CATERPILLAR.

Platysamia cecropia (Linn).

This caterpillar, larger than the foregoing, also sometimes occurs on

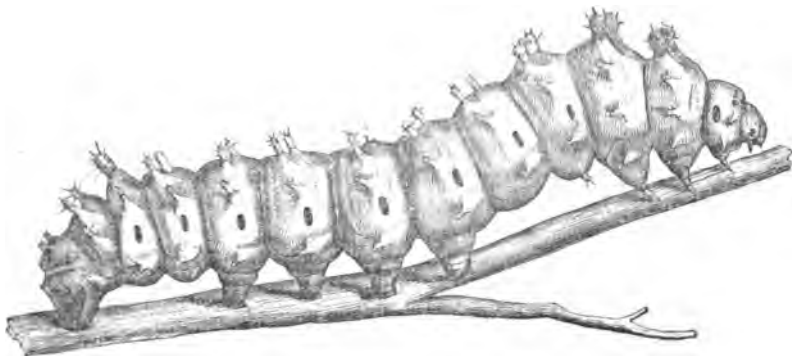


FIG. 52.—Caterpillar of the Cecropia silk moth, nat. size.—After Riley.

the maple. It is about four inches long, and pale green, ornamented with large tubercles colored green, blue, yellow, and red.

19. THE MAPLE SEMI-LOOPER.

Ophiura bistriaris (Hübner).

Order LEPIDOPTERA; family NOCTUIDÆ.

Late in July feeding on the silver maple, a brownish gray caterpillar 1.40 inch long, with the first pair of prolegs small, the worm having a semi-looping gait.

When about to go into chrysalis it cuts through a portion of a leaf of the tree on which it has fed, and turning it over constructs a snug little case, fastening it up closely and carefully with silken threads, and in this completes its transformations. After remaining in the pupa state about two weeks, the moth appears. (Saunders.)

The larva is 1.40 inch long, somewhat onisciform. Head medium sized, flattened, bilobed; color, pale ashen gray with streaks of pale brown appearing under a magnifying lens as a fine network; a dark brown, nearly black, stripe on each side, and a few short gray hairs scattered over its surface. Body above brownish-gray, with numerous streaks and dots of pale brown. A double irregular dorsalline; other broken lines composed chiefly of dots, none of them continuous. A subdorsal row of whitish dots. On the hinder part of the 12th segment is a raised crescent-shaped line edged

behind with black, and on the terminal one two whitish dots, with a small black patch at their base. Spiracles pale oval, edged with black. Under surface paler and greenish, feet greenish, prolegs bluish-green dotted with brown. The moth is rather large, with broad triangular fore wings, and is uniformly brown, with two oblique darker bands.

20. THE MAPLE LEAF-CUTTER.

Incurvaria acerifoliella (Fitch).

Order LEPIDOPTERA ; family TINEIDÆ.

Cutting round holes in the leaves and consuming their pulp in rings and semi-circular spots, and using the round pieces to hide the small white worms between them and the leaf, forming a broad round case adhering to the surface of the leaves.

This larva with its singular case has been described by Fitch, and we have received specimens of maple leaves and cases from Vermont. Early in August the leaves of forest trees begin to wither, and holes appear in them, the orbicular pieces being taken by the little worm to form a broad scale concealing it. The worms fall with the leaves to the ground in the autumn, and there remain transforming in their cases, and late in the spring appear as moths.

The larva.—Nearly a quarter of an inch long; slender, cylindrical, soft, and contractile; dull white; head flattened, and, like the three succeeding segments, pale rusty brown.

The moth with long narrow pointed wings; the fore pair brilliant steel-blue, the hind wings smoky brown, with purplish reflections. Between the antennæ a dense tuft of erect bright orange-yellow hairs. (Fitch.)

The following insects also infest the maple:

21. *Gastropacha americana* Harris. (Lintner, Contr. iii.)
22. *Nadata gibbosa* Sm.—Abb. (Lintner, Contr. iii, 150.)
23. *Nematocampa filamentaria* Guen. (Lintner, Contr. iii, 165)
24. *Amphidasys cognataria* Guen. (Lintner, Contr. iii, 166.)
25. *Heterophelps triguttata* H.—Sch. (Saunders in Packard's Monogr. Phalænidæ.)
26. *Lithocolletis aceriella* Clemens. Larva in a flat blotch mine in upper surface of leaves.
27. *Lithocolletis lucidicostella* Clemens. } Larvæ in tentiform mines in un-
28. *Lithocolletis clemensella* Chamb. } der surface of leaves.
29. *Gracilaria packardella* Chamb. Larva rolls the leaf downward into a conical figure.
30. *Catastega aceriella* Clems. Larva only known. It at first mines the leaf, and afterwards constructs a case of its frass. (Does not belong to Tineidæ !)
31. *Xylotrechus colonus* (Fabricius). Found by Mr. G. Hunt under the bark of an old sugar maple in Northern New York.

HEMIPTERA.

32. *Psylla annulata* Fitch. Occurs on the sugar maple.
33. *Siphonophora acerifoliæ* Thomas. On soft maple, *Acer dasycarpum*, Iowa, Illinois, and Missouri.

34. *Aphis aceris* Linn. Occurs on *Acer pensylvanica* (Fitch).
 35. *Lecanium acericola* Walsh and Riley. (Amer. Ent. i, 14.) Also on box elder (Thomas).
 36. *Lecanium acericorticis* Fitch. On silver maple, Washington, D. C. (Glover, Sm. Rep. 1876. See Thomas vii, 120; American Naturalist, xii, 655, 808.)

DIPTERA.

37. *Cecidomyia aceris* Shimer. On *Acer dasycarpum*. (Trans. Amer. Ent. Soc., i, 281.)

INSECTS INJURIOUS TO THE COTTONWOOD.

(*Populus monilifera*.)

AFFECTING THE TRUNK AND BRANCHES.

1. THE POPLAR BORER.

Saperda calcarata Say.

Order COLEOPTERA; family CERAMBYCIDÆ.

In the Western States, including Colorado, causing widespread injury and destruction to the cottonwood trees. (Riley. See the poplar borer, p. 117.)

2. *Hyperplatys aspersus* Say.

Boring in dry twigs at Columbus, Tex.; the perfect insect to be found throughout spring and summer, according to Schwarz. (Riley.)

3. *Oberea schaumii* Leconte.

The larva burrowing in the twigs, making a very smooth cylindrical burrow, the perfect insect appearing in the middle of June at Saint Louis, Mo. (Riley.)

4. *Oberea mandarina* Fabr.

The larva boring in the thin twigs at Saint Louis, Mo., the imago issuing in the middle of April. (Riley.)

5. *Dorytomus mucidus* Say.

Running on and flying about cottonwood trees early in April and again in August. In October it is found under dead bark of trees in winter quarters. Common. Illinois. (A. S. McBride. Can. Ent. XII, 106.)

6. *Eros coccinatus* Say.

Found in April in Illinois in the cottonwood, under logs in the woods. (McBride, loc. cit.)

AFFECTING THE LEAVES.

7. THE STREAKED COTTONWOOD BEETLE.

Plagioderma scripta (Fabricius).

Order COLEOPTERA; family CHRYSOMELIDÆ.

An abundant beetle, infesting the leaves of the cottonwood and other species of *Populus* and of willows throughout the West to Colorado, and south to Louisiana,

destroying vast groves; three annual broods; the larva peculiar from emitting from the tips of its tuberculous spines a pungent milky fluid; transforming on the leaf, the pupa remaining in the partially cast-off larva skin; the beetle usually black on the prothorax, with the sides yellow and the wing-covers yellowish, with three interrupted lines of black or bluish spots. It may be destroyed by syringing the trees with a wet preparation of London purple or Paris green. (Riley, Amer. Ent. iii, 159.)

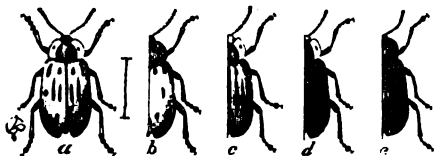


FIG. 53.—Streaked cottonwood beetle: a, beetle, normal form; b, c, d, e, showing variations.—After Riley.



FIG. 54.—Grub of streaked cottonwood beetle: a, eggs; b, one enlarged; c, newly hatched larva; d, d, d, larvae of different ages; e, pupa, nat. size; f, one of the middle segments of the body of larva seen from above, showing tubercles, enlarged. After Riley.

8. THE COTTONWOOD DAGGER-MOTH.

Acronycta populi Riley (*lepusculina* Guen.?)

Devouring the foliage and not unfrequently stripping the tree, a caterpillar which rests curled around on the leaf, and is easily recognized by its body being covered with long, soft, bright-yellow hairs, and a long pencil of black hairs on top of segments 4, 6, 7, 8, and 11. (Riley.)

This caterpillar is sometimes destructive to the foliage of the cottonwood in Missouri. There are two broods of these worms each year; the first brood appearing in June and producing

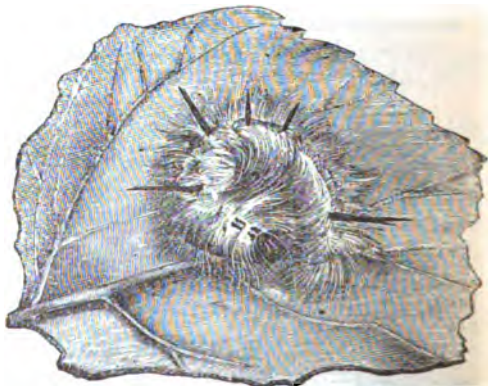


FIG. 55.—The cottonwood dagger-moth and its caterpillar.—After Riley.

moths by the last of July, the second brood appearing the last of Au-

gust and throughout September, and passing the winter in the chrysalis state. It is attacked by several parasites, *i. e.*, a *Microgaster*, an *Ophion*, and a *Tachina* fly.

The chrysalis is dark shiny brown, and ends in an obtuse point furnished with several forked bristles. It is formed within a pale yellow cocoon of silk interwoven with the hairs of the caterpillar and is generally spun in some sheltered place, as in a chink in the bark of a tree, etc.

The moth.—Fore wings white-gray near the anal angle between veins 1 and 2, a large and conspicuous spot like a Greek letter *psi*, placed sidewise, and from this spot a somewhat zigzag line runs parallel with the posterior border, forming a large dart-like spot between veins 5 and 6. (Riley.)

9. *Smerinthus modesta* Harris.

Larva on cottonwood in Illinois. (C. E. Worthington, Can. Ent., x, 16.)

10. *Pemphigus populi-transversus* Riley.

Forming a gall upon the petiole near the base of the leaf of *Populus monilifera* and *P. balsamifera*. Missouri, Southern Texas, and Colorado. (Riley.)

11. *Pemphigus populi-monilis* Riley.

On the narrow-leaved cottonwood in Colorado.

12. *Pemphigus populi-ramulorum* Riley.

13. *Pemphigus pseudobyrsa* Walsh.

Occurs on *Populus angulata*. (Thomas viii, 151.)

14. *Pemphigus vagabundus* Walsh.

Produces a large irregular gall on the tips of the twigs of certain cottonwoods. (Thomas viii, 151.)

15. *Pemphigus populicaulis* Fitch. (Le Baron.)

Also occurs on the aspen (*Populus tremuloides*) in Wisconsin. (Thomas viii, 149.)

16. *Chaitophorus populicola* Thomas.

Found in July at Carbondale, Ill., and early in September on the under side of young sprouts of *Populus angulata* (cottonwood).

INSECTS INJURIOUS TO THE POPLAR

AFFECTING THE TRUNK.

1. THE POPLAR BORER.

Superda calcarata Say.

Order COLEOPTERA; family CERAMBYCIDÆ.

Often destroying the Lombardy poplar, a yellowish-white grub, nearly two inches long, and changing to a gray longicorn beetle, irregularly striped with yellow ochre, the wing-covers ending in a sharp point, flying in August and September.

Harris states that this borer, with the grubs of the broad-necked *Prionus*, almost destroyed the Lombardy poplars in his vicinity (Cambridge, Mass.), and that it also lives in the trunks of the native poplar.

The beetles rest on the trunks and branches of various kinds of poplars in August and September, and also fly by night, sometimes entering the open windows in the evening. According to Riley this borer is universally destructive to the cottonwood in the Western States.

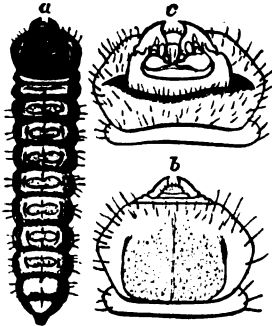


FIG. 56.—Poplar borer: *a*, natural size; *b* upper and *c* under side of head and first thoracic segment enlarged.—From Packard.

The larva.—About two inches long; the body very thick, rather larger before than behind; the segments full and rounded. The first segment broad, sloping obliquely downward to the head. On the upper side of the broad segment (prothoracic) containing the head is a large square yellowish horny area, succeeded by rough oval areas on the tops of the succeeding segments. These rasps serve as legs, which are wanting in the grub.

The beetle is called the spurred Saperda (*calcarata*) from the spine-like ends of the wing-covers. The body is covered all over with a short and close nap, which gives it a fine blue-gray color; it is finely punctured with brown, with four ochre-yellow lines on the head and three on the top of the thorax; the scutellum is also ochre-yellow, and there are several irregular lines and spots of the same color on the wing-covers; it is $1\frac{1}{2}$ inch in length. (Harris.)

2. THE LESSER POPLAR BORER.

Saperda mæsta Leconte.

Boring in the poplar and balm of Gilead, selecting the smaller branches, in many places not more than an inch or two apart, and situated chiefly at the base of the buds, the whole length of the excavation not much exceeding an inch; pupating early in May and becoming beetles by the end of May.

The larva.—Nearly cylindrical, tapering a little posteriorly, and about half an inch in length. Head very small, dark reddish brown in front, pale behind. Body deep yellow. Second segment deeper in color and more horny than the other segments; terminal segment a little more hairy than the others. (Saunders.)

3. THE POPLAR GIRDLER.

Saperda concolor Leconte.

Girdling the trunks of sapling poplars, by carrying a mine around the trunk, which causes a swelling often nearly twice the diameter of the tree.

Our attention was first directed to this borer and the marked effects of its work by Mr. George Hunt. In his company we have found numerous saplings of the common poplar in the woods about Providence, with the unsightly swellings around the trunk. The beetle is uniformly gray approaching the color of the downy under side of the poplar, with no spots, while the antennæ are black, stained with gray at the joints. Length 10^{mm}.

4. THE BROAD NECKED PRIONUS.

Prionus laticollis Drury.

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in the wood of the trunks and roots of different poplars, a white soft grub as thick as one's thumb, producing an oval moderately convex black long-horned beetle 0.90 to 1.50 long and less than half as broad, its wing-covers rough from confluent irregular punctures and with two or three raised lines, its thorax with three irregular

teeth along each side, and its antennæ of twelve joints resembling little conical cups placed one within the other and projecting upon their lower side like the teeth of a saw; appearing abroad in July. (Fitch.)

Though of late years injurious to the apple, grape-vine, and pine, this beetle may originally have been confined to the poplars, especially as Harris does not enumerate the above-mentioned trees, but says that it lives in the trunks and roots of the balm of Gilead, Lombardy poplar, "and probably in those of other kinds of poplar also. The beetles may frequently be seen upon, or flying around, the trunks of these trees in the month of July, even in the daytime, though the other

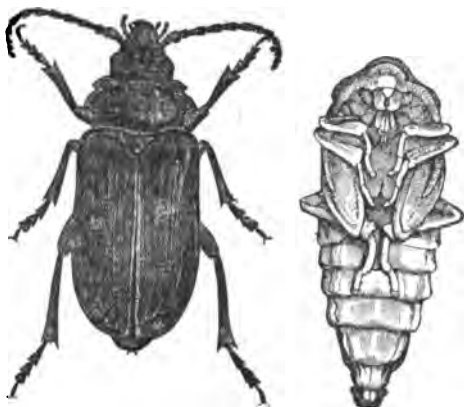


FIG. 57.—Broad-necked Prionus and pupa.—After Riley.

kinds of Prionus generally fly only by night." Prof. S. J. Smith, in his report as Entomologist to the State Board of Agriculture of Connecticut, for 1872, remarks: "I have noticed it in logs of poplar, bass-wood, and oak, and in the trunks of old, decaying apple trees, and Professor Verrill has collected it in great

numbers, at New Haven, in chestnut railroad ties," p. 346. It seems to us most probable that this borer also infests the pitch-pine, since

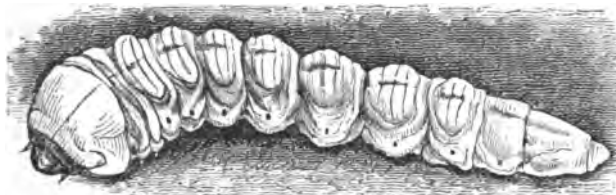


FIG. 58.—Larva of broad-necked Prionus.—After Riley.

we have seen these beetles flying at noon in abundance in the middle of July on the sandy plains of Brunswick, Maine, among pitch-pines, two or three miles away from any poplars; and have captured them among pines at intervals for twenty-five years past.

5. THE XYLECTES BORER.

Xylectes populi Walker.

Nothing is known to us concerning this moth, except that the specific name indicates that it occurs on the poplar. The habitat mentioned by Walker, is St. Martin's Falls, Albany River, Hudson's Bay, the original specimen described by Walker being in the British Museum.

6. THE POPLAR GOAT-MOTH.

Cossus centerensis Lintner.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Perforating the trunks of *Populus tremuloides*, a worm similar to, but smaller than, the oak caterpillar (*X. robinia*), the moth issuing from the trees during June. (Bailey.)

Usually trees less than a foot in diameter are attacked by this worm;

a number occurring in the same tree, according to the account of Mr. J. S. Bailey. (Can. Ent. XI, p. 1.) The eggs are laid by the long ovipositor of the female in the deep crevices of the bark of the poplar. When hatched, *i. e.*, during the summer, they bore into the tree, never apparently ceasing to eat, and extending their tunnels through solid wood, first in the alburnum and then through the heart, the burrows increasing in size with that of the larvæ, until the latter are completely grown. In consequence of the innumerable tunnels cut in feeding, many trees are destroyed. The burrows made by the larvæ are about 15 millimeters in width, and terminate in the pupating cell, which is about 40^{mm} long, and smooth; the extremity toward the opening is closed by a wad of finer and then coarser filings of the wood. The coarser splinters are *not* detached entirely from the wood, but are split up by the larva all around the top of the cell and project like bristles. These splinters make a firm wad. Against them are piled a quantity of finer chips or thin filings, which are loose, but pressed together.

The cell is about 40^{mm} from the outer bark of the tree, and the chrysalis makes its exit through the burrow by means of the teeth on the segments and the spinous process on the front, by which it forces itself by stretching and contracting the abdomen through the wood scrapings which close the cell until it comes to the end.

The larva is supposed to live two years, and attains maturity in October, the moth issuing from the trees the following June and July, leaving the empty shell of the chrysalis sticking out of the hole. It is preyed upon in the larva state by an ichneumon fly. (Bailey.) It occurs near Albany (Bailey) and in Michigan (Kellicott).

The larva is 45^{mm} long, of a pale flesh color. The first segment behind the head is blackish-brown above, the dark color edged with a dirty orange shading. Head mahogany brown; along the sides of the body a row of brown dots above the reddish stigmata, and a row of similar dots, two to a segment, on each side of the dorsal line, from each of which a hair arises.

The pupa is about 30^{mm} long, narrow brown-black, shining, rugose. On the clypeus is a strong broad spinous process, supported at base by lateral projections. The abdominal segments are provided with teeth on the back, and the anal segment is provided with two unequal sized terminal teeth on each side of the vent.

The moth, says Mr. Bailey, seems to belong to the genus *Cossus* Fabr., and not to be congeneric with *Xyleutes robinia*. The head is short, eyes naked, labial palpi small, oppressed, scaled. The thorax is thickly scaled, and is squarer in front than *Xyleutes*, and not so long or high. The male antennæ are bipectinate; those of the female serrated. It is allied to the European *Cossus terebra*, while a larger insect. It differs from *C. querciperda* by the absence of any yellow on the male hind wings, and by its darker color and closer reticulations. In color it is black and gray; fore wings covered with black reticulations. The ground color is blackish over nearly two-thirds from the base of the fore wings, and outwardly gray. Beyond the cell is a transverse continuous line, broader than the rest, and outwardly bent over the median veins. Hind wings rounded in both sexes, with blackish hairs at base, pale and sub-pellucid, with short gray fringe, before which there is a narrow blackish edging. Abdomen blackish. Male smaller than the females; the smallest male expanding about 40^{mm}, the largest female over 60^{mm}. (Bailey.)

6. THE POPLAR ÆGERIA.

Ægeria tricincta Harris.

Boring in *Populus canadensis* in winter and spring, the moth perhaps placing her eggs in the deserted burrows of *Saperda moria*. They inhabit the branches, suckers, and small trunks in New York, on the smaller stalks raising galls. The larva dull white, head light brown, otherwise much as in other Ægerian caterpillars. (Described by D. S. Kellicott in Can. Ent. XIII, 3.)

AFFECTING THE LEAVES.

7. THE STOUT POPLAR SPAN WORM.

Biston ursaria Walker.

Order LEPIDOPTERA; family PHALÆNIDÆ.

In some seasons, during July, partially defoliating the Lombardy poplars in Montreal, Canada, large drab or dingy purple span worms, at the end of July burying themselves in the earth, the moths appearing during the last week in April and the early part of May.

According to Mr. G. J. Bowles (Can. Ent. VIII, p. 7) this span worm abounds year after year in the Lombardy poplars in the city of Montreal. "In some seasons the trees are partially defoliated by the larvæ, and during the last week of April and the first of May the moths are to be found in great numbers." On the 6th of May the moths laid globular eggs .04 inch in diameter, depositing them some days before the leaves expand. May 29th the larvæ began to hatch out just as the poplars were throwing out their leaves. The larvæ change but little during growth. At the end of July they descend and bury themselves in the earth, changing in a few days to pupæ, without forming any cocoon.

The larva is from 2 to 2½ inches long, of a drab or dingy purple; head of a lighter shade and spotted with black. First segment behind the head bordered in front with a yellow line, indented behind; fourth to eighth inclusive, each with six very small yellow tubercles, two on the back, one behind and one below each spiracle. Body striped from head to tail with twelve reddish lines, each bordered on both sides by an irregular narrow black line; six of the reddish lines are on the back and sides, one (interrupted) through the spiracles, and four on the abdomen. Anal segments spotted with black, as also first, second, and third segments. Mouth pinkish, legs pink-spotted with black; spiracles dark. (Bowles.)

The moth.—This genus may be known by the large heavy body and rather small wings; the fore wings have the costa straight, the tip subrectangular; the male antennæ with long pectinations. This species is dark granite-gray, the fore wings with three transverse, obscure, dusky lines, represented in rubbed specimens by black spots on the costa and veins. First line well curved; second and third lines near together. Half way between the third line and the outer edge of the wing is a fainter band than the others, represented by a costal square spot, and a black spot on the inner angle. Hind wings with three transverse diffuse bands. The fore wings expand 1.55–2.00 inches.

8. THE WHITE-S CLOSTERA.

Ichthyura albosigma Fitch.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Early in July, eating the leaves and reposing in a cavity formed of leaves drawn together like a ball, a large black caterpillar with white and yellow dots and stripes

and a hump on the back of its fourth and eleventh rings; its pupa lying in a cocoon attached among the leaves, and in ten days giving out the moth the latter part of July; the moth grayish-brown, its fore wings crossed by three faint paler streaks, the two first parallel, the hind one with its outer half silvery white and strongly waved in shape of the letter S; width, 1.50.

9. THE AMERICAN CLOSTERA.

Ichthyura Americana Harris.

Consuming the leaves in summer, a pale yellow caterpillar with two little black warts close together on the back of its fourth and eleventh rings, three slender black lines on its back and three in a broad dusky stripe along each side, its pupa passing the winter in a cocoon under leaves or rubbish on the ground, the middle of June giving out a pale grayish moth more or less varied with brown, its fore wings with three whitish bands, the first transverse and dislocated, the second oblique and giving off a transverse branch from its middle which runs to the inner margin, uniting with the third band, the two thus forming a letter V, a faint whitish band across the middle of the hind wings; width about 1.35. (Harris.)

10. V-MARKED CLOSTERA.

Ichthyura vau Fitch.

A moth which is very similar to the preceding, but darker colored and smaller, with the bands more slender and distinct, may be readily distinguished from that species by its having the first band not dislocated, but in its middle strongly curved backward, the apex of the curve usually forming an acute point. The last band also is much more strongly undulated near its outer end, curving backwards almost in a semicircle, and is of a much more vivid white color, and broadly bordered on its hind side with bright rust-red. Its hind wings also are destitute of the paler band across their middle. Its width is about 1.20.

I am unacquainted with its larva, but, like the other species of this genus, it doubtless feeds on the poplars and willows. Though quite rare in my own vicinity, it is oftener met with than the two other species. (Fitch.)

11. THE POPLAR-STEM GALL-LOUSE.

Pemphigus populicaulis Fitch.

Forming imperfectly globular galls the size of a bullet at the junction of the leaf with its stalk, these galls having a mouth-like orifice on their under side, and a large cavity within, crowded with small dull white lice and their white cast skins, and with winged lice of a blue black color, their antennae reaching beyond the base of their wings, the rib-vein of their fore-wings black, thick, much thicker at its apex along the inner margin of the stigma, and the short veinlet bounding the anterior end of this spot more slender than the rib-vein; its length 0.10, and to the tips of its wings 0.15. (Fitch.)

12. THE POPLAR GALL-LOUSE.

Pemphigus popularia Fitch.

Late in autumn, wandering up and down the trunk of the balsam poplar, a gall-louse closely like the preceding, but its abdomen green, its antennae short, reaching but two-thirds the distance to the wing sockets, and the rib-vein of its wings not thicker along the inner margin of the stigma; its length 0.13 to the tip of its wings.

The female black, slightly dusted over with a glaucous gray powder; the abdomen

dull green with a small coating of white flocculent wool, its opposite sides parallel and its tip abruptly rounded; the antennæ short, thick, and thread-like; the wings dull hyaline, their rib-vein black and the oblique veins slender and blackish with the basal third of the third vein abortive and the fourth vein perceptibly thicker towards its base; and the small branch of the rib-vein bounding the anterior end of the stigma having nearly the same thickness with the rib-vein. (Fitch.)

13. THE POPLAR-BULLET GALL-LOUSE.

Pemphigus populi-globuli Fitch.

In July, on the leaves of the balsam poplar slightly above their base, an irregular globular apple green gall the size of a bullet, projecting from the upper surface of the leaf, with a curved mouth-like orifice on the under side, the cavity within containing numerous small pale green and smaller dusky lice with the end of their bodies covered with short white cotton-like threads, and larger winged ones which are of a black color, with the abdomen dusted over with white meal and with thin white woolly fibres on the back, and their antennæ reaching the base of the wings, which are clear hyaline, their veins slender and white or colorless, except the outer marginal vein, which is black to the end of the stigma, and also the rib-vein, which is much thicker at its apex; their length 0.07 and to the tip of their wings 0.11.

14. THE POPLAR-VEIN GALL-LOUSE.

Pemphigus populi-venæ Fitch.

In July an oblong compressed excrescence like a cock's comb, of a light red color varied with pale yellow, growing from the midvein of balsam poplar leaves on their upper side with an orifice on the opposite under side; a cavity within containing a multitude of lice and their white cast skins, interspersed with a whitish meal-like powder; those with wings being black, with coarse thread-like antennæ reaching to the base of the wings, which, with their oblique veins, are pellucid and colorless, the coarse rib-vein being blackish and more thick at its tip along the inner margin of the stigma, and the vein of the outer margin being blackish and somewhat coarse from its base to the stigma; its length 0.05 and to the tip of the wings 0.08.

Other insects occurring on the poplar are the following:—

15. *Superda vestita* Say. On poplar in July, Providence (G. Hunt, p. 124).
16. *Xyleutes robinia* Harris. In *Populus candicans*. (Kellicott Bull. Buffalo Soc. Nat. Sc., iv, 30.)
17. *Ageria tibiale* Harris. Found in New Hampshire on *P. candicans* Harris. (Amer. Journ. Sc., xxxvi, 1839, 309.)
18. *Limenitis misippus* (Lintner, Contr., ii, 166).
19. *Lemenites disippus* B.-Lec., Lintner, Proc. Ent. Soc. Phil., 1866).
20. The prickly caterpillar, *Hyperchiria io* (Fabricius). On balsam poplar and aspen (Lintner, Contr., ii, 146.)
21. The prickly black caterpillar, *Vanessa antiopa* (Linn).
22. Elm measuring worm, *Eugonia subsignaria* Hübner.
23. *Notodonta dictava* Linn. On aspen (Lintner, iv, 77).
24. *Cossus undosus* Lintner (Contr., iv, 130). At Green River, Wyoming, probably on *P. balsamifera*.
25. *Smerinthus modesta* Harris. On aspen (Kellicott).
26. *Tephrosia cribrataria* Guenée. Larva on *Populus tremuloides* and *P. fastigiata* (Guenée).

The following Tineidæ occur according to Chambers on the poplars, aspens, &c.:

27. *Cemiosstoma albella* Chamb.
28. *Batrachedra salicipomonella* Clemens.
29. *Batrachedra præangusta* Haworth.
30. *Batrachedra striolata* Zeller.
31. *Aspidisca* sp? makes a minute mine in aspen leaves in Oregon. Possibly it is *A. splendoriferella* Clemens.
32. *Gracilaria populiella* Chamb. Larva rolls aspen leaves in the Rocky Mountains.
33. *Gracilaria purpuriella* Chamb. Larva mines leaves of silver-leaf poplar.
34. *Lithocolletis populiella* Chamb. Larva in a tentiform mine in under side of leaves of silver poplar.
35. *Appis populifoliae* Fitch. On under side of leaves of *Populus grandidentata* (Thomas, viii, 102).
36. *Chaitophorus candicans* Koch. Balm of Gilead.

INSECTS INJURIOUS TO THE LINDEN TREE.

AFFECTING THE TRUNK.

1. THE LINDEN BORER.

Saperda vestita Say.

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring in the trunk, undermining the bark for six or eight inches in sinuous galleries, or penetrating the solid wood an equal distance, rather slender grubs, with three pairs of thoracic feet, transforming into a greenish snuff-yellow longicorn beetle, with six black spots near the middle of the back.

The beetles, according to Dr. Paul Swift, as quoted by Dr. Harris, were found in Philadelphia upon the small branches and leaves

May 28, and it is said that they come out as early as the first of the month, and continue to make their way through the bark of the trunk and large branches during the whole of

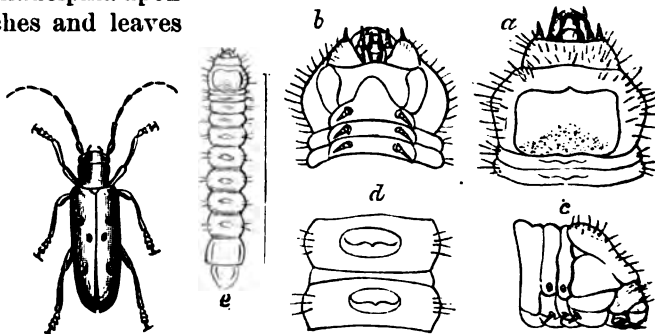


FIG. 59.—The Linden borer, beetle of nat. size. a, upper, b, under, side of head and three thoracic segments; c, side view of head of grub; d, top view of two segments, showing the oval spots; e, the grub, slightly enlarged.—(From Packard.)

the summer. They immediately fly into the top of the tree, and there feed upon the epidermis of the tender twigs and the petioles of the leaves, often wholly denuding the latter, and causing the leaves to fall.

They deposit their eggs, two or three in a place, upon the trunk or branches, especially about the forks, making slight incisions or punctures for their reception with their strong jaws. As many as ninety eggs have been taken from a single beetle.

AFFECTING THE LEAVES.

2. THE LIME INCH-WORM.

Hibernia tiliaria Harris.

Order LEPIDOPTERA; family PHALÆNIDÆ.

In May and June, defoliating the branches, a bright yellow looper or measuring worm with a rust-colored head, and ten crinkled black lines along the back, descending at the end of June to the ground and pupating three or four inches under the surface of the soil; appearing as moths with their buff-brown wings in October and November.

While this worm is often found on apple and elm trees, the lime or linden is its proper food-tree. The females are wingless and grub-like, much larger than the female canker-worm moth, white, marked with two dorsal rows of black patches; they lay their eggs in little clusters in crevices in the trunk or in the branches, and in the spring when the leaves begin to unfold they hatch.

Their habits are similar to those of the canker-worm, and the best means of protection against them are those employed against the canker-worm, i. e., the use of tarred paper daubed over with printer's ink or troughs of oil around the trunk of trees to prevent the females from ascending the trees to lay their eggs.

The male.—Pale ochreous, with light brown specks and bands. Head, body, front or costal edge of the fore wings and transverse band on the wings concolorous, being pale brown. Fore wings with a point, curved, sinuate, diffuse inner line; outer line dark brown, slightly sinuate, with a large obtuse angle in the middle of the wing; it is shaded externally with a broad pale-brown band, which breaks up into flecks on the outer edge; a well-marked discal dot. Hind wings without any markings, somewhat paler than the fore pair. Expanse of wings 2 inches.

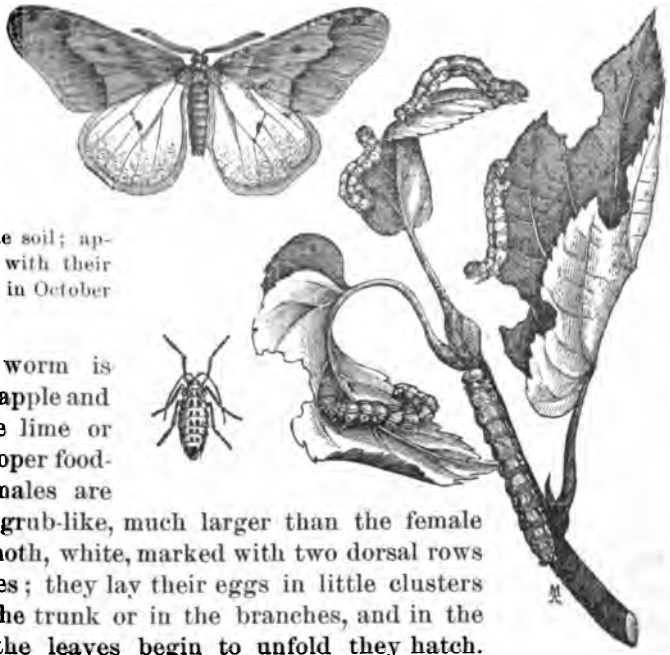


FIG. 60.—The lime inch worm.—From Comstock.

3. THE LINDEN LEAF-BEETLE.

Chrysomela scalaris Leconte.

Order COLEOPTERA ; family CHRYSOMELIDÆ.

Injuring the leaves, a stout-bodied beetle with silvery wing-covers spotted with green, laying eggs on the leaves in the spring, from which fat, thick-bodied white grubs develop, with a lateral row of large black dots, which also prey on the leaves.

While this beautiful and abundant beetle is more common on the alder, it also occurs on the lime-tree and elm. They may be found on these trees in April, May, and June, and a second brood in September and October. We have taken them *in coitu* on the alder in Maine the middle of May. The grubs are hatched from eggs laid by the beetles on the leaves in spring and come to their growth towards the end of June in Massachusetts, according to Harris, who believes that they go into the ground to turn to pupæ.

The beetle is about three-tenths of an inch in length, the body almost oval, hemispherical; head, thorax, and under side of the body dark green, the wing-covers silvery white, ornamented with small green spots on the sides, and a broad jagged stripe along the suture or inner edges; the antennæ and legs are rust red, and the wings rose-colored.

The larva is short and thick, the back curving up in the middle about six-tenths of an inch long, white, with a black line along the top of the back, and a row of small square black spots on each side of the body; the head is horny, and of an ochre yellow. (Harris.)

Since the foregoing account was prepared, we have during the past summer observed this beetle in all its stages. At Brunswick, Maine, during July and August, 1881, it was very abundant on the numerous linden trees in the campus of Bowdoin College, eating rounded holes in the leaves and causing them to turn yellow and unsightly, as if to prematurely fall. Nearly every tree and, in some cases, nearly every leaf on a tree was infested by the disgusting pale grubs, while scattered patches of eggs occurred on the under side of the leaves; and during the first to last of August the beetles were found not uncommonly upon the leaves. The trees could be protected by showering the leaves with London purple in water when the grubs first appear late in June. From these specimens the following descriptions were drawn up:

Egg.—Rather large, oval cylindrical, yellow, several together attached by one end; about 1.5^{mm} in length.

Larva.—Body very thick, curved up like that of the grub of the Colorado potato-beetle, being much swollen behind the thoracic segments, while the tip of the abdomen is curved down. Head honey-yellow, darker over the jaws; antennæ bluish, except at base; eyes black. Prothoracic shield blackish in the young before the last molt; in full-grown individuals not all black, but pale, with four irregularly square black spots. Body behind dirty white, with a row of dorsal and lateral dusky spots. Legs pale, spotted with black at the joints. A pair of meso-thoracic spiracles and 8

pairs of smaller abdominal ones. Low down, on the sides of the second and third thoracic segments a curvilinear black spot. Length, 8-9mm.

Pupa.—Body pure white; prothoracic shield, with long scattered hairs around the edge and in two groups on the back; antennæ curving around between the eyes and jaws, and with the ends resting on the tips of the elytra. The insect undoubtedly descends into the earth to pupate.

The beetle.—Head, prothorax, and under side of body dark coppery green, with scattered pits. Antennæ palpi and legs pale pitchy yellow; elytra coppery green and whitish, the green forming a broad median stripe, sending prolongations outwards toward the middle of the elytra, the first pair of branches nearly parallel to the band, the second becoming more and more at right angles to the band, the last short and broad near the tip of the body. Eleven rounded dark-green spots in the whitish field; the pair near the shoulders gourd-shaped; two of the spots behind the middle of the elytra touching each other. The pits or punctures near the sutures of the elytra arranged in three lines parallel to the median line of union of the body; elsewhere they are arranged irregularly.

The following insects also occur on the linden :

4. *Selandria tiliæ* Norton (Trans. Amer. Ent. Soc., i, 250).
5. The swallow tail, *Papilio turnus* Linn (Ent. Soc. Ontario).
6. The semicolon butterfly, *Grapta interrogationis* (Fabricius).
7. *Ceratomia amyntor* Hübn. (Lintner i, 188).
8. *Acronycta hastulifera* (Sm. Abb.), Lintner (Contr. iii, 158).
9. *Apatela americana* Harris.
10. *Sciapteron robiniae* H. Edwards. Destructive to *Populus alba* in Nevada (Edwards, Bull. Buffalo Ent. Soc., iii, 72).
11. *Eugonia alniaria* Hübn. (Harris).
12. The elm measuring worm, *Eugonia subsignaria* (Hübner).
13. The maple moth, *Acronycta americana* Harris.
14. The leaf-miner beetle, *Hispia quadrata* Fabr. Mines the leaves. (Chambers.)
15. *Prionus brevicornis* Fabr. In logs of bass wood (Smith, Rep. Ent. Conn. 1872, 346).
16. *Parandra brunnea* Fabricius (in stumps, Schaupp, in letter).
17. The Linden dipterous gall-fly, *Cecidomyia (tiliæ) verrucicola* Ostensacken. Massachusetts and New York (Ostensacken).
18. *Lithocolletis lucetiella* Clems. Larvæ in tentiform mine on under surface of leaves. (Chambers.)
19. *Lithocolletis tiliæella* Chamb. Larvæ in tentiform mine on upper surface of leaves. (Chambers.)
20. *Coleophora tiliæfoliella* Clems. Larva only known. It lives in a case and feeds on the under side of leaves. (Chambers.)
21. *Cecidomyia citrina* O. Sacken.
22. *Lachnus longistigma* Monell. St. Louis, Mo.
23. *Drepanosiphum tiliæ* Koch? (Monell-Thomas).;

INSECTS INJURIOUS TO THE BIRCH.

(Betula lenta, etc.)

AFFECTING THE LEAVES.

1. THE TRIPLE-ROWED SYNETA.

Syneta tripla Say.

Order COLEOPTERA; family CHRYSOMELIDÆ.

In May and the fore part of June, eating the leaves of this and various other trees, an oblong chestnut-brown and closely punctured beetle, with wing-covers usually pale dull yellowish except on their suture, and their punctures forming about three rows between each of the three raised lines; its length 0.25 and about a third as wide. A common insect in New York. (Fitch.)

2. THE VARIABLE LEAF-HOPPER.

Athysanus variabilis Fitch.

Order HEMIPTERA; family CERCOPIDÆ.

Puncturing the leaves and succulent shoots and extracting their juices, from the middle of June till the middle of July, an oblong oval leaf-hopper of a sulphur yellow color, its wing-covers commonly with an oblique black stripe, their tips hyaline; its thorax and scutellum often tawny yellow or black; its length 0.20. (Fitch.)

This insect may every year be met with in numbers upon birch trees and also upon alders. It was once found literally swarming upon a white birch standing apart from other trees. (Fitch.)

3. THE SMALLER LEAF-HOPPER.

Athysanus minor Fitch.

From the middle of June till the middle of August, a similar leaf-hopper to the preceding, but of a cinnamon color, including its face, and having a colorless hyaline spot on the middle of its wing-covers and a larger one on their tips; its length 0.18 to 0.20. (Fitch.)

4. THE WINDOWED LEAF-HOPPER.

Athysanus fenestratus Fitch.

From the middle of June till the last of July, a leaf-hopper resembling the foregoing species, but with blackish wing-covers with similar hyaline spots and a smaller third one placed on the middle of the inner margin, and its forehead black with a pale yellow band between its eyes; its length 0.20 inch. (Fitch.)

The following insects also occur on the birch* :—

5. *Chrysobothris 6-signata* Say. Beetle and pupa found in the yellow birch June 1, Providence.

* In Europe *Rhenanaptera hastata* (Hübner) and *Operophtera boreata* Hübner live upon the birch; these are common insects in the Northern United States, but their habits have not yet been observed.

6. *Tylonotus bimaculatus* Hald. Under bark of white or paper birch, Northern New York. (G. Hunt.)
7. *Bellamira scalaris* (Say). Beetle and pupa found under the bark of the yellow birch in July, Northern New York. (G. Hunt.)
8. *Oræsus latitarsus* Norton. Saw-fly. (Bred by Walsh. Trans. A. Ent. Soc., i, 84.)
9. The black-birch borer, *Xiphidria attenuata* Norton. Inhabits the black birch. Patton. (Can. Ent. XI, 15.)
10. *Tremex columba* Linn. In yellow birch at Providence.
11. *Gastropacha americana* Harris. On *Betula lenta*. (Lintner Contr., i, 193, iii, 154.)
12. *Brephos infans* Moeschler. Lintner, Contr., iv.
- 13-14. *Telephorus cordinus* and *fraxini* occurred in Maine June 2, the former in *ovitu*, on the leaves of *Betula populifolia*.
15. *Callaphis betulella* Walsh. Abundant in Illinois on *Betula nigra*. Proc. Ent. Soc. Phil., i, 301.
16. The spruce leaf-hopper, *Athysanus abietis* Fitch.
17. The butternut tinging; *Tingis juglandis* Fitch.
18. *Callipterus betulæ* Koch ? The birch aphid.
9. *Callipterus betulæcolens* Thomas. Saint Louis, Mo.

INSECTS INJURIOUS TO THE BEECH.

(Fagus ferruginea.)

1. THE BEECH SPAN-WORM.

Hyperetis nysaria Abbot.

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding on the leaves the middle of September, a dark brown span or measuring worm, changing to a beautiful delicate thin-winged moth.

According to Mr. W. Saunders two larvæ were found by him on the beech, the 10th of September, in London, Canada. Two of them entered the chrysalis state on the 19th of September, having formed a rude case in which to secrete themselves by binding two leaves together with threads of silk. One of them, he says, produced the imago on the 18th, the other on the 21st of May following.

The caterpillar is dark brown, the body cylindrical and an inch long. Head medium sized, bilobed, dark brown, with the bluish-white lines in front. Body above dark brown, with a row of dull white dots on each side, one or two on each segment most prominent from fifth to eighth segments inclusive, less distinct towards each extremity. On the posterior part of ninth segment are two rather prominent roundish black tubercles, with a few whitish streaks in front at their base. Terminal segment of a bluish tint, flattened and spreading. (Saunders.)

The moth.—The moths of the genus *Hyperetis* have long rather narrow fore wings with the apex acute, bent on the outer edge, which is sinuous. The species is pale whitish ash, dusted over with black specks. On the fore wings is an inner curved

pale brown line, wider on the costa, and an outer line making a great bend in the middle of the wings. Beyond the outer line the wing is brown, either reddish or umber brown, with dark cross specks, and two diffuse spots near the middle; one near the head of the outer line and another near the tip of the wing. The hind wings are sinuous on the outer edge; the wings expand from an inch to an inch and a half.

2. THE BEECH LEAF-MINER.

Brachys æruginosa Gory.

Order COLEOPTERA; family BUPRESTIDÆ.

Mining the leaves of the beech, a whitish flattened larva, changing to a small flattened hard-shelled beetle.

Dr. Harris has given in his "Treatise" an account of the larva of *Hispa* which mines the leaf of the apple tree, eating the pulpy substance between the upper and under surface of the leaf. The insect of which we now treat belongs to the family of Buprestids, several species of which, as we have seen, do much injury to our fruit and shade trees in the grub state. They are footless grubs and recognized by the broad, rounded, flattened segment just behind and partially enclosing the head. The young of *Brachys*, etc., depart somewhat from this typical form owing to their peculiar leaf-mining habits. The first of these is the young of the *Brachys æruginosa*, which has been found by V. T. Chambers, Esq., of Covington, Ky., mining the leaves of the beech tree, and I am indebted to him for a specimen of the larva here figured (Fig. 60½).

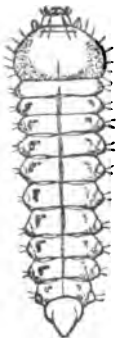


FIG. 60½.—The beech leaf-miner, much enlarged.—From Packard.

I may remark here that a closely allied beetle (*B. terminans*) is often to be seen in Maine resting on the leaves of the oak and beech. The beetles of this genus are flattened, angular ovate, and less than a quarter of an inch in length, and the scutellum is small, as Leconte observes, while the shanks (tibiæ) are linear. In the succeeding genus, *Metonius*, Leconte says that the body is triangular, while the scutellum is large, and the shanks are dilated.

Larva.—The body of the larva is rather long, with the segments very deeply cut, being flattened, and produced laterally into a triangular projection, giving a serrate outline to the body, the teeth being obtusely rounded. The segment next behind the head is the widest, the succeeding segments gradually decreasing in width and increasing slightly in length to the end. The terminal segment is about half as wide as the body in its widest portion, and is somewhat triangular, with the sides parallel, and the tip obtusely pointed. The prothoracic segment or the one next the head is broader than long, and has a fleshy projection on each side at the base of the head. On the upper side of this segment is a large, square, slightly horny area. The head is anteriorly pale honey yellow, with two dark longitudinal parallel lines; the horny portion is about as long as broad, much flattened, subtriangular. The antennæ are very minute, slender, three-jointed, with the joints nearly equal in length. The jaws and palpi are so minute that a description will be of no practical use here. The body is finely shagreened, with a few fine scattered hairs. It is whitish, with a slight greenish tinge, and a quarter (.25) of an inch long, and less than a tenth (.07) of an inch broad. It was sent to me alive in September.

The following insects also occur on the beech :

3. *Dicerca divaricata* Say. (Fitch; and Schaupp in letter; observed by Mr. George Hunt laying its eggs in the bark in July. See Fitch, 3d Report, 48.)
4. *Scolytus fagi* Walsh. (Pract. Ent., ii, 58.)
5. *Parandra brunnea* Fabr. (Schaupp in letter.)
6. *Osmoderma scabra* Beauv. (Schaupp in letter.)
7. *Actias luna* (Linn.). (Saunders Can. Ent. vii, 33.)
8. *Smodicum cucujiforme* Say. (See p. 28.)
9. *Dryobius 6-fasciatus* Say. (C. G. Siewers.)
10. *Goes pulverulentus* Haldeman. "The insect is very destructive to living beech trees. It bores into those branches which are about three inches in diameter. The length of the channel is about eight inches." (Horn.)
11. *Acanthoderes 4-gibbus* Say. Bores in dead twigs of beech. (Schwarz.)
12. *Hoplosia nubila* Leconte. "Larva boring in dry beech twigs. Detroit, Michigan, Schwarz." (Riley.)
13. *Cryptolechia faginella* Chamb. The larva sews together the leaves in August and later. (Chambers.)
14. *Schizoneura imbricator* Fitch. Beech tree blight.
15. *Schizoneura fagi* (Linn.).

The following deciduous trees mentioned in their botanical order are affected by the insects enumerated below, and which for the most part feed upon the leaves :

TULIP TREE (*Liriodendron tulipifera*).

Order LEPIDOPTERA.

1. *Callosamia promethea*, var. *angulifera* Walker. (Akhurst in Riley, Bull., vi, 55.)
2. *Samia cynthia* Hübner. (G. D. Hulst, Bull. Brooklyn Ent. Soc. i, 91.)
3. *Bronchelia hortaria* Guenée. (Abbot MS. in Guenée.)
4. *Phyllocnistis liriodendrella* Clem. Makes a long, winding linear mine on either surface of the leaves. (Chambers Bull., Hayden's U. S. Geol. Surv., 1878, iv, 108.)

Order COLEOPTERA.

5. *Acanthoderes morrisii* Uhler. (Leconte, Trans. Amer. Ent. Soc. viii, xxiv.)

Order HEMIPTERA.

6. *Siphonophora liriodendri* Morell. (Saint Louis, June and July, Morell.)
7. *Lecanium tulipiferae* Cook. (American Naturalist, xiii, 324.)

Order DIPTERA.

8. *Cecidomyia liriodendri* O. Sacken. (Monogr., i, 204, on leaves.)
9. *Cecidomyia tulipiferae* O. Sacken. (Monogr., i, 202.)

MAGNOLIA (*Magnolia umbrella*, and probably other species).

Order LEPIDOPTERA.

The larva of *Phyllocnistis magnoliæella* Chambers makes a long, winding linear mine on either surface of the leaves. The imago is unknown, and it may prove to be *P. liriodendronella* Clem. (Chamb. Bull., Hayden's U. S. Geol. Surv., 1878, iv, 108.)

PAPAW (*Asimina triloba*).

1. *Sphinx hylæus* Drury. (Proc. Amer. Ent. Soc., iii, 434.)
2. *Amphalocera cariosa* Lederer. (Larva described by French, Rep. Curator S. Illinois Normal Univ., 1880, 46.)

PRICKLY ASH (*Zanthoxylum americanum*).

Order COLEOPTERA.

1. *Liopus zanthoxyl*i Shimer. (Trans. A. E. Soc. ii, viii. Described in full by Packard in 1st Rept. Ins. Mass., Boston, 1871, p. 13. Fig. of larva and adult.)
2. *Micracis suturalis* Leconte (Shimer, l. c.).

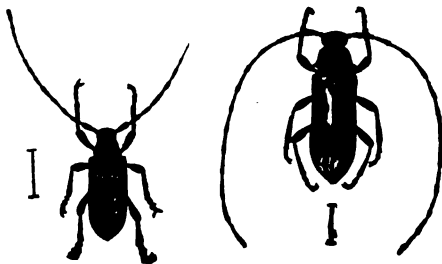


FIG. 61.—*Liopus zanthoxyl*.—From Packard.
FIG. 62.—*Liopus facetus*.—From Packard.

Order LEPIDOPTERA.

3. *Papilio cresphontes* Cramer. Larva found chiefly on prickly ash, *Z. fraxineum*, and on *Dictamnus fraxinella* in Canada West. (Saunders

in Rept. Ent. Soc., Ontario, 1880.) In Texas on *Z. carolinianum* (Boll. Psyche, ii, 289.) In Southern Illinois prickly ash is its usual food. (French.)

TREE OF HEAVEN (*Ailanthus glandulosus*).

Order LEPIDOPTERA.

1. *Samia cynthia* Hübner. (Imported.)
2. *Oeta compta* Clemens. (Riley's 1st Report.)

BUCKEYE OR HORSE-CHESTNUT (*Æsculus glabra*).

Order LEPIDOPTERA.

1. *Orgyia leucostigma* (Sm. Abb.).
2. *Acronycta hastulifera* (Sm. Abb.). Also feeds on linden. (Lintner, 26th Rept. N. Y. State Mus., 158.)
3. *Protosteras æsculana* Riley. (Trans. St. Louis Acad. Sc., iv, 321. "Larvæ boring the tender terminal twigs of buckeye and maple in Missouri.")
4. Buckeye stem-borer, *Sericoris inscrutana* Clemens.

5. *Tortrix larva*.*
6. *Lithocolletis guttifinitella* Clem., var. *æsculisella* Chamb. Larva in flat, blotch mine in upper surface of leaves. (Chamb., l. c.)

BOX ELDER (*Negundo aceroides*).

Order LEPIDOPTERA.

1. *Gracilaria negundella* Chamb. Larva curls down the edge of a leaf.

Order HEMIPTERA.

2. *Pulvinaria innumerabilis* Rathvon. (Comstock, N. Amer. Ent., i, 25)
3. *Chaitophorus negundinis* Thomas. (In Illinois in June, Miss Smith, Thomas, 8th Rept. Ill., 103.)

Order COLEOPTERA.

4. *Chrysobothris femorata* (Fabr.).

MESQUITE (*Prosopis*).

Order COLEOPTERA.

1. *Chrysobothris octocola* Leconte. (Texas, Arizona, and Colorado River of California; lives in species of *Prosopis*. Leconte, Rev. of Buprestidæ of U. S. Trans. Am. Phil. Soc., 1859, 230.)
2. *Cyllene antennatus* White. ("Lives in the mesquite wood," Arizona, Horn. Trans. Am. Ent. Soc., viii, 135.)
3. *Bruchus uniformis* Leconte. (Colorado Desert. Abundant in the pods of *Prosopis* and *Strombocarpus*. Leconte.)
4. *B. prosopis* Leconte. (Found with the preceding. Leconte.)

HONEY LOCUST (*Gleditschia triacanthus*).

Order LEPIDOPTERA.

1. *Heterogenea shurtleffi* Packard. (Shurtleff in Packard's Synopsis of Bombycidæ.)
2. *Anisopteryx vernata* Peck. (Feeding on the leaves in Providence, May and June. Packard.)
3. *Laverna ? gleditschiella* Chamb. Larva burrows in the thorns. (Chambers, l. c.)
4. *Helice pallidochrella* Chamb.
5. *Agnippe biscolorella* Chamb. The larvæ of these species no doubt feed in some way on this tree. A larva (of one of them ?) feeds in the "honey" inside the seed-pods. (Chambers, l. c.)

* Several Tortricid larvæ occurred on the leaves of the horse-chestnut at Salem, Mass., August 20-27, of which the following is a brief description: Paler reddish brown, curiously mottled with pale green, forming much interrupted, very irregularly-edged brown lines. Beneath, grass-green. Head greenish, irregularly speckled with brown. A dark green dorsal line. It spun a cocoon of silk, with very fine bits of leaves woven in.

Order COLEOPTERA.

6. *Bruchus* sp. (Hentz in Harr. Corr., 39.)

Order DIPTERA.

7. *Cecidomyia gleditschiae* O. Sacken. (Proc. Ent. Soc. Phil., vi, 219, Newport, R. I.)

WILD CHERRY* (*Prunus serotina*).

Order HYMENOPTERA.

1. *Abia cerasi* Fitch.
2. *Oræsus latitarsus* Norton. (Aug. 16, Norton, Trans. Am. Ent. Soc., i, 84.)

Order LEPIDOPTERA.

3. *Papilio turnus* Linn. (Lintner, Contr., iii, 131.)
4. *Smerinthus myops* Harris. (See also Hulst in Bull. Brooklyn Ent. Soc., iii, 99.)
5. *Smerinthus excrucatus* (Smith). (Lintner, iv, 188.)
6. *Hyperchiria io* (Fabr.).
7. *Callosamia promethea* (Drury.)
8. *Samia cynthia* Hübner. (Feeding in freedom. P. E. Nostrand, Bull. Brooklyn Ent. Soc., ii, 77.)
9. *Clisiocampa americana* Harris.
10. *Cerura borealis* Harris. (French, Can. Ent. xiii, 145.)
11. *Catocala ultronia* Guenée. (Florida, Koebele in Bull. Brooklyn Ent. Soc., i, 44.)
12. *Apatela radcliffei* Harvey. (R. Thaxter in Psyche ii, 121.)
13. *Tortrix cerasivorana* Fitch. (N. Y., Fitch; Maine, Packard.)
14. *Lithocolletis cratagella* Clem. (Larva in tentiform mine in under surface of leaves. Chambers, l. c.)
15. *Aspidisca splendoriferella* Clem. (Larva in a minute, flat mine in August, and later cuts out a case in which it pupates. Also occurs on *P. coronaria*. Chambers, l. c.)
16. *Ornix prunivorella* Chamb. (Larva at first in a tentiform mine in under surface of leaves, at the margin; leaves the mine to pupate. Chambers, l. c.)
17. *Coleophora pruniella* Clem. (Imago unknown; the larva lives in a case which it attaches to the leaves. Chambers, l. c.)
18. *Nepticula?* *prunifoliella* Clem. (Insect unknown. Dr. Clemens gave the name to an unknown larva, possibly Dipterous, which makes a crooked, linear mine on the upper surface of the leaves. Possibly it is identical with the next species. Chambers, l. c.)
19. *Nepticula serotinælla* Chamb. (Larva makes a red, crooked linear mine in the upper surface of the leaves. Chambers, l. c.)

* The list of insects affecting the wild cherry and wild red plum, service-berry, and thorn is confessedly very imperfect.

20. *Machimia tentoriferella* Clem. (Imago unknown; the larva lives in a web on the under side of a leaf. Chambers, *l. c.*)

Order DIPTERA.

21. *Cecidomyia serotinæ* O. Sack. (Trans. Amer. Ent. Soc., iii, 346. New York. Osten Sacken.)

Order COLEOPTERA.

22. *Dicerca divaricata* Say. (Harris, etc.)

CHOKE CHERRY (*Prunus virginiana*.)

Order LEPIDOPTERA.

1. *Cælodasys unicornis* (Sm. Abb.). This interesting caterpillar feeds not only on the hazel, but also the choke cherry, according to Mr. Lintner. It also occurs on the apple and plum. It is to be found in August.
2. *Hyperchiria io* (Fabr.).

Order COLEOPTERA.

3. *Uroplata rosea* Weber. (Harris.)

Order HEMIPTERA.

4. *Aphis cerasifoliæ* Fitch. (June, Sauk City, Wisconsin, Bundy., Thomas 8th Rept., 93.)

RED WILD PLUM (*Prunus americana*.)

Order LEPIDOPTERA.

1. *Lithocolletis crataegella* Clem. (Larva as in *Prunus serotina*; also on *P. coronaria*. Chambers, *l. c.*)
2. *Anarsia pruniella* Clem. (Larva feeding in woody excrescences. Chambers, *l. c.*)
3. *Evippe prunifoliella* Ohamb. (Larva feeds under the tip of the leaf turned down. Chambers, *l. c.*)
4. *Xylesthia pruniramiella* Clem. (Larva feeds in woody excrescences. Chambers, *l. c.*)

Order COLEOPTERA.

5. *Oonotrachelus nenuphar* (Herbst.). (Plum weevil, on wild plum, Canada. Saunders, Rept. Ontario Ent. Soc., 1880.)

Order HEMIPTERA.

6. *Mytilaspis conchiformis* (Gmelin).

JUNE OR SERVICE BERRY (*Amelanchier canadensis*.)

Order LEPIDOPTERA.

1. *Ornix quadripunctella* Clem. (Larva in a tentiform mine in the leaves. Chambers, *l. c.*)

2. *Nepticula amelanchierella* Clem. (Larva makes a linear, crooked mine in the leaves ; imago unknown. Chambers, l. c.)

Order COLEOPTERA.

3. *Saperda bivittata* Say. Apple tree borer.
4. *Uroplata rosea* Weber. (Harris, 120.)

MOUNTAIN ASH (*Pyrus americana*.)

1. *Acronycta occidentalis* G. & Sh.
2. *Chrysobothris femorata* Fabr. (Harris Correspondence, 311.)
3. *Saperda bivittata* Say. Apple tree borer.
4. *Mytilaspis pomicorticis* Riley.

PEAR OR BLACK THORN, HAWTHORN, ETC. (*Crataegus* different species).

Order LEPIDOPTERA.

1. *Papilio turnus* Linn. (Brunswick, Me., Sept. 5 ; larva.)
2. *Thecla falacer* Godart. (Harris, 276.)
3. *Caelodasy unicornis* Sm. Abb. (On thornbush at Brunswick, Me., Sept. 5.)
4. A notodontian allied to the foregoing. (Maine, Sept. 5.)
5. *Spilosoma virginica* Fabr. (On buckthorn, middle of September, Maine.)
6. *Orgyia antiqua* (Linn.). (Injuring thorn hedge in Rhode Island. Miss Dix, Amer. Journ. Sc., xix, 1st series. Harris, 369.)
7. *Lithocolletis crataegella* Clem. (Larva and mine as in *P. serotina*. Chambers, l. c.)
8. *Aspidisca splendoriferella* Clem. (Larva and mine as in *P. serotina*. Chambers, l. c.)
9. *Tischeria malifoliella* Clem. (Larva in a flat, trumpet-shaped, yellowish mine in upper surface of leaves. Chambers, l. c.)
10. *Ornix crataegifoliella* Clem. (Larva in tentiform mine on under side of leaves. Chambers, l. c.)
11. *Ornix inusitatumella* Chamb. (Larva in white, flat mine, speckled with "frass," in upper surface ; pupates in the mine. Chambers, l. c.)
12. *Nepticula crataegifoliella* Clem. (Larva in a crooked, linear mine in upper surface of leaves ; imago unknown. Chambers, l. c.)

Order DIPTERA.

13. *Cecidomyia cratagi-bedeguar* Walsh. (Can. Ent., i, 179 ; Proc. Ent. Soc. Phil., vi, 266, on *Crataegus tomentosa*. In the same paper Mr. Walsh mentions galls on *Crataegus*, which he calls *cratagiplica*, *limbus* and *globulus*, without giving any further description. Osten Sacken, Cat. Dip.)

Order COLEOPTERA.

14. *Saperda bivittata* Say. On hawthorn.
15. *Conotrachelus crataegi* Walsh. (Proc. Bost. Soc. Nat. Hist., ix, 1863, 311.)
16. *Xylotrechus convergens* Leconte. Bred from branch of an undetermined *Crataeus*, locally known as Red Haw. Iowa. (Leconte, Trans. Amer. Ent. Soc. viii, xxiv.)
17. *Gaurotes cyanipennis* Say. In spring on thorn blossoms and later in the season pairing and ovipositing on butternut. (Caulfield, Can. Ent. 1881, 60.)

Order HEMIPTERA.

18. *Aphis crataegifolii* Fitch. (On leaves of *C. punctata*. Fitch.)
19. *Siphonophora crataegi* Monell. (July, Saint Louis, Monell.)

SWEET GUM (*Liquidambar styraciflua*).

Order LEPIDOPTERA.

1. *Actias luna* (Linn.).
2. *Callosamia promethea* (Drury).
3. *Eacles imperialis* Hübner. (Smith-Abbott.)
4. *Phyllocnistis liquidambarisella* Chamb. (Larva in a long, winding, linear mine in upper surface. Chambers, l. c.)

Order COLEOPTERA.

We have found Buprestid and longicorn borers in a dead sweet gum tree at Houston, Texas, in April.

5. *Mytilaspis pomicorticis* Riley ?

GUM TREE (*Nyssa multiflora*).

1. *Darapsa chærilus* (Cram.). (G. D. Hulst, Bull. Brooklyn Ent. Soc. ii, 77.)

PERSIMMON (*Diospyros virginiana*).

Order LEPIDOPTERA.

1. *Orgyia leucographa* Walker. (Larva described by French, Rep. Curator S. I. Normal Univ., 1880, 44.)
2. *Aspidisca diospyriella* Chamb. (Larva in a minute blotch mine, from which it cuts out a case in which it pupates. Chambers, l. c.)

Order HEMIPTERA.

3. *Aphis diospyri* Thomas. (8th Rep., Ill., 5.)

CALIFORNIAN BAY OR LAUREL (*Laurus*).

1. *Ptilinus basalis* Leconte. (Trans. Amer. Ent. Soc. viii, xxiii.)
2. *Micracis hirtella* Leconte.

ASH (*Fraxinus americana*, *pubescens*, *sambucifolia*, etc.).

Order LEPIDOPTERA.

1. *Sphinx kalmia* Sm.—Abb. (Lintner, Contr. i, 188.)
2. *Sphinx chersis* G. & R. (*cinerea* Harris.) (Proc. Ent. Soc. Phila. iii, 655.)
3. *Sphinx gordius* Cramer. (Black ash.)
4. *Daremma undulosa*. (Black ash, Lintner, Contr. ii, 128.)
5. *Smerinthus geminatus* Say. (Psyche, ii, 72.)
6. *Ægeria denudatum* Harris. (Can. Ent. xiii, 8.)
7. *Callosamia promethea* (Drury.)
8. *Hyperchiria io* (Fabr.).
9. *Halesidota maculata* (Harris). (Corr. 290.)
10. *Clisiocampa sylvatica* Harris. (Can. Ent. ix, 159; Riley, 3d Rt. 126.)
11. *Apatelodes angelica* Grote. (Lintner, Contr. iii, 130.)
12. *Anisopteryx vernata* Peck. (Black ash, John Sears in Packard's Monograph of Geometrid Moths, 404.)

Order COLEOPTERA.

13. *Neoclytus caprea* (Say). (Thomas Ins. Illinois, vi, 151.)
14. *Tylonotus bimaculatus* (Hald.). (Riley in Amer. Ent. iii, 239, also in "tulip poplar.")
15. *Hylesinus opaculus* Leconte. (Riley, Ag. Dept. Rt. 1879, 45.)
16. *Thysanocnemis fraxini* Leconte. (Rhyncophora, 214.)
17. *Hylesinus aculeatus* Say. (Rhyncophora, 379.)

Order HEMIPTERA.

18. *Pemphigus fraxinifolii* Thomas. (On ash, June, Wisconsin, Bundy in Thomas Rt. viii, 146.)

Order DIPTERA.

19. *Cecidomyia peller* O. Sacken. (Galls on leaves of *Fraxinus americana*.)

SASSAFRAS (*Sassafras officinale*).

Order LEPIDOPTERA.

1. *Papilio troilus* Linn. (Harris Corr., 271.)
2. *Callosamia promethea* (Drury).
3. *Samia cynthia* Hübner. G. D. Hulst, Bull. Brooklyn Ent. Soc. i, 91.)
4. *Hyperchiria io* (Fabr.).
5. *Coscinoptera dominicana* Fabr. (Riley.)
6. *Gracilaria sassafrasella* Chamb. (Larva, when very young, mines the leaves; when older, rolls them downwards. Chambers, l. c.)

SYCAMORE (*Platanus occidentalis*).

Order COLEOPTERA.

1. *Cyllene crinicornis* Chevr. On *Platanus* in Texas, Dr. Brous. (Leconte in Trans. Amer. Ent. Soc. viii, xxiv.)

Order LEPIDOPTERA.

2. *Eacles imperialis* Hübner.
3. *Halesidota tessellaris* (Sm.-Abb.).
4. *Anchylopera platanana* Clemens.
5. *Ianthaphe platanella* Clemens.
6. *Nepticula platea* Clem.
7. *Nepticula maximella* Chamb.
8. *Nepticula clemensella* Chamb. (Larva of these three species in the upper surfaces of the leaves. See Can. Ent., v, 125. Chambers.)
9. *Cirrha platanella* Chamb. (Larva feeds on the under side of the leaves, and pupates in a tube composed of silk and the down from the leaves. Chambers.)

HAZEL (*Corylus americana*).

Order LEPIDOPTERA.

1. *Apatela brumosa* Guenée. (Angust, Ill., Coquillett, "Papilio," i, 56.)
2. *Zerene catenaria* (Drury.) (July, Aug., Ill., Coquillett, "Papilio," i, 56.)
3. *Lithocolletis coryliella* Chamb. Larva in a nearly circular blotch mine in the upper surface.
4. *Nepticula corylifoliella* Clem. Imago unknown. Larva in a linear, crooked mine in the upper surface.
5. *Gelechia coryliella* Chamb. Imago unknown. Larva in the male catkins in autumn.
6. *Hyale coryliella* Chamb. (Larva in a web on under surface of the leaves. Chambers, l. c.)

Order COLEOPTERA.

7. *Balaninus nasicus* Say. (Eating the nuts. Harris, 74.)
8. *Attelabus rhois* Boh? Rolls attached to the drier leaves like those of *A. rhois* on the alder.

HORNBEAM, IRONWOOD (*Ostrya virginica*).

Order LEPIDOPTERA.

1. *Smerinthus juglandis* Sm. Ab. (Taken fully grown Sept. 5, N. Y. Lintner.)
2. *Lithocolletis obscuricostella* Clem.
3. *Lithocolletis ostryæfoliella* Clem. (Larvæ of both species in tentiform mines in under side of leaves. Chambers, l. c.)
4. *Lithocolletis coryliella* Chamb.
5. *Lithocolletis tritæniæella* Chamb. (Larva in roundish blotch mine in upper surface of the leaves.)
6. *Ææa ostryæella* Chamb. (Larva in a flat mine between two ribs, with a row of "frass" on each side. Chambers, l. c.)
7. *Aspidisca ostryæfoliella* Clem. (Imago unknown. Larva in a minute blotch mine in upper surface of leaves, from which it cuts out its pupal case. Chambers, l. c.)

8. *Nepticula ostryæfoliella* Clem.
9. *Nepticula virginella* Clem. (Imago of both species unknown. Larvæ make linear, crooked mines in upper surface of leaves. Chambers, l. c.)
10. *Gracilaria ostryæella* Chamb. (Imago unknown. The larvæ when very small makes a linear, whitish mine in the upper surface of the leaves. Chambers, l. c.)
11. *Coleophora ostryæ* Clem. (Imago unknown. The larva lives in a case and feeds on the under surface of the leaves. Chambers, l. c.)

Order HEMIPTERA.

12. *Psylla carpini* Fitch.

WATER BEECH, HORNBEAM (*Carpinus americana*).

Order LEPIDOPTERA.

1. *Lithocolletis coryliella* Chamb.

Order DIPTERA.

2. *Cecidomyia pudibunda* O. Sacken. (On the leaves, District of Columbia. O. Sacken.)

ALDER (*Alnus serrulata*, etc.).

Order HYMENOPTERA.

1. *Nematus* sp. (A rather large, dirty yellowish false-caterpillar, in clusters on the leaves. Brunswick, Me., Packard.)

Order LEPIDOPTERA.

2. *Eacles imperialis* Hübner. (G. D. Hulst, Bull. Brooklyn Ent. Soc., ii, 77.)
3. *Acronycta* sp. (Common on the leaves in August and September. Maine, Packard.)
4. *Acronycta acericola* Guenée. (Feeds on birch and alder. Riley, Rt. ii, 121.)
5. *Lithocolletis alnivorella* Chamb.
6. *Lithocolletis alnifoliella* Hübner.
7. *Lithocolletis auronitens* Frey and Boll. (The larvæ of these three species live in tentiform mines in the under side of the leaves. Chambers, l. c.)
8. *Gracilaria alnicolella* Chamb.
Gracilaria alnivorella Chamb. (When very young the larvæ of these two species mine the leaves; when older, they roll them downward; *alnicolella* from the tip, *alnivorella* from the side. Chambers, l. c.)
9. *Lyonetia alniella* Chamb. (The larva makes a large, brownish blotch mine in the leaves. Chambers, l. c.)

Order DIPTERA.

10. *Cecidomyia serrulatæ* O. Sacken. (District of Columbia, on *Alnus serrulatæ*. O. Sacken. Monogr., i, 198.)

Order COLEOPTERA.

11. *Dichelonycha elongatula* (Schönhen). (*In coitu*, June 10, Brunswick, Me. Packard.)
 12. *Calligrapha scalaris* Leconte. (Maine, Packard.)
 13. *Attelabus rhois* Boh. (Rolling up the leaves into cylinders in June and July, depositing an egg in the center. Orono, Me., Packard. Memoirs Peabody Academy of Science, Salem, iii, 1872, 7.)
 14. *Saperda* (Mecas) *inornata* Say. (Making temporary galls in saplings of *Salix longifolia*.)
 15. *Saperda lateralis* Fabricius. (Mr. George Hunt has found this beetle attacking the alder in Rhode Island.)
 16. *Pogonocherus mixtus* Hald. Abundant. (Can. Ent., iii, 1881, 60.)

Order HEMIPTERA.

17. *Lachnus alnifoliæ* Fitch.
 18. *Schizoneura tessellata* Fitch. (Alder blight. Common in Maine.)

WILLOW (*Salix* various species).

Order HYMENOPTERA.

The following list of saw-fly larvæ, producing galls on different species of willow, is taken from Walsh, Proceedings of the Entomological Society of Philadelphia, v, 284.

1. *Euura orbitalis* Norton. (Galls on *Salix humilis* Walsh.)
2. *Euura S. gemma* Walsh. (On *Salix humilis*.)
3. *Euura S. ovum* Walsh. (On *Salix cordata*.)
4. *Euura S. ovulum* Walsh. (On *Salix humilis*.)
5. *Euura S. nodus* Walsh. (On *Salix longifolia*.)
6. *Nematus S. pomum* Walsh. (On *Salix cordata* and very early on *S. discolor*.)
7. *Nematus S. desmodioides* Walsh. (On *Salix humilis*.)
8. *Nematus S. pisum* Walsh. (On *Salix discolor*.)
9. *Nematus inquilinus* Walsh. (Guest, bred from Cecidomyidous gall *S. rhodoides*.)
10. *Nematus hospes* Walsh. (Guest, bred from Cecidomyidous gall *S. rhodoides*.)
11. *Nematus mendicus*. (Guest, bred from gall of *N. s. pomum*.)
12. *Nematus fur* Walsh. (Guest, bred from gall of *C. s. batatas* on *Salix humilis*.)
13. *Pristiphora sycophanta* Walsh. (Guest, in gall of *C. s. brassicoides*.)

Order LEPIDOPTERA.

14. *Vanessa antiopa* (Linn). (Brunswick, Me., June ; Providence, June, Packard.)
15. *Limenitis misippus* Fabr. (Lintner, Contr., ii, 166.)
16. *Apatelodes torrefacta* Sm. Ab. (Eats willow leaves. Harris, Corr., 307.)
17. *Notodonta dictæa* (Linn). (September, N. Y., Lintner, Contr., iv, 76.)
18. *Smerinthus geminatus* Say. (Psyche ii, 72.)
19. *Smerinthus excrucatus* Harris. (Can. Ent. x, 16.)
20. *Actias luna* (Linn).
21. *Samia cynthia* (Linn). "Feeding voluntarily in freedom." P. E. Nostrand (Bull. Brooklyn Ent. Soc., ii, 77.)
22. *Eacles imperialis* Hübner. G. D. Hulst (Bull. Brooklyn Ent. Soc., ii, 77.)
23. *Hyperchiria io* (Fabr.).
24. *Pheosia rimosa* Packard. Larva on willow. (F. Tepper in Bull. Brooklyn Ent. Soc., ii, 3.)
25. *Cerura borealis* (Boisd.). (August and September, N. Y., Lintner, Contr., iii, 151.)
26. *Cerura multscripta* Riley. (F. Tepper in Bull. Brooklyn Ent. Soc., i, 4.)
27. *Cerura occidentalis*. (Larva described by French, Can. Ent., xiii, 144.)
28. *Euchronia maia* (Fabr.). (Wescott, Can. Ent., 1877, 220.)
29. *Xyleutes robinæ* Harris. (Kellicott, Bull. Buffalo Soc. Sc. iv, 30, 1881.)
30. *Acronycta americana* Harris MS. (Trouvelet, Lintner, Contr., iii, 136.)
31. *Acronycta salicis* Harris. (August, Harris, Corr., 315.)
32. *Scoliopteryx libatrix* (Linn). (Lintner, Contr., iii, 164; Illinois, Aug. Coquillet.)
33. *Catocala parta* Guen. (Lintner, Contr., iii, 164.)
34. *Catocala concumbens* Walker. (Saunders, Proc. Amer. Ent. Soc., ii, 29.)
35. *Homoptera salicis* Behr. (On willows in California. Behr. W. A. E. Soc., iii, 28.)
36. *Metrocampa perlaria* Guenée. (Saunders, Can. Ent., iii, 226.)
37. *Hydria undulata* (Hübner). (In Europe feeds on the willow; not yet observed in United States.)
38. *Cymatophora pampinaria* Guenée. (Larva noticed, French in "Pappilio," i, 82.)
39. *Grapholitha gallæsaliciana* Riley. (Trans. St. Louis Acad. Sc., iv, 320. "Bred from galls on willow twigs." Riley.)
40. *Lithocolletis salicifoliella* Chamb. (and Clem?). (Larva in a tentiform mine in the under surface of leaves. Chambers, l. c.)
41. *Gracilaria salicifoliella* Chamb. (Larva in a blotch mine in upper surface of the leaves. Chambers, l. c.)

42. *Gracilaria purpurilla* Chamb. (Larva rolls the leaves from the tip.)
43. *Cemiosoma albella* Chamb. (Larvæ in large blackish blotch mines. Chambers, l. c.)
44. *Aspidisca saliciella* Clem. and Chamb. (Larva in a minute blotch mine, from which it cuts out its pupal case. Chambers, l. c.)
45. *Nepticula fuscotibiella* Clem. (Larva in a linear mine bent back in itself. Chambers, l. c.)
- 46, 47. *Nepticula*. Two unknown species make narrow, linear, crooked mines, one of which is in the upper and the other in the lower surface of the leaves. (Chambers, l. c.)
48. *Marmara salicella* Clem. Larva burrows in young twigs. (Chambers, l. c.)
49. *Batrachedra præangusta* (Haworth.)
50. *Batrachedra salicipomonella* Clem.
51. *Batrachedra striolata* Zeller. (The specific distinctness of these three species seems to me not sufficiently established. *B. salicipomonella* was bred from galls made by other insects on willows. The mode of feeding of the others is not satisfactorily determined. Chambers, l. c.)
52. *Gelechia salicifungella* Clem.
53. *Gelechia fungivorella* Clem. (Larvæ of these two species in galls made by Cynips. Chambers, l. c.)
54. *Gelechia* sp.? Imago unknown. The larva sews together willow leaves at great elevations in the Rocky Mountains.

Order DIPTERA.

The following gall-flies occur on the willow, according to Walsh, who gives a synopsis of cecidomyioid galls of the genus *Salix* in Proceedings of the Entomological Society of Philadelphia, iii, p. 575.

55. *Cecidomyia S. brassicoides* Walsh. (On *Salix longifolia*.)
56. *Cecidomyia S. strobiloides* Osten Sacken. (On *S. cordata*.)
57. *Cecidomyia S. strobiliscus* Walsh. (On *S. rostrata* and *S. discolor*.)
58. *Cecidomyia S. gnaphalioides* Walsh. (On *S. humilis* and *S. discolor*.)
59. *Cecidomyia S. rhodoides* Walsh. (On *S. humilis*.)
60. *Cecidomyia S. coryloides* Walsh. (On *S. discolor*? and *S. discolor*.)
61. *Cecidomyia S. cornu* Walsh. (On *S. humilis*.)
62. *Cecidomyia S. siliqua* Walsh. (On *S. humilis*, *S. cordata*?, and *S. discolor*.)
63. *Cecidomyia S. nodulus* Walsh. (On *S. longifolia*.)
64. *Cecidomyia S. triticoides* Walsh. (On *S. cordata*.)
65. *Cecidomyia S. hordeoides* Walsh. (On *S. humilis*.)
66. *Cecidomyia S. batatas* Walsh. (On *S. humilis*, *S. cordata*?, and *S. discolor*?)
67. *Cecidomyia S. verruca* Walsh. (On *S. humilis* and *S. discolor*.)

Guest or inquiline galls.

- 63. *Cecidomyia alborivittata* Walsh. (On galls of *C. s. strobiloides* and *s. strobiliscus*.)
- 69. *Cecidomyia orbitalis* Walsh. (On galls of *C. s. batatas* and *Tenthredinoides*, gall *s. ovulum*.)
- 70. *C. cornuta* Walsh. (In willow stems bearing galls of *C. s. brassicoides*.)
- 71. *Diplosis atrocularis* Walsh. (In gall of *C. s. strobiloides*.)
- 72. *Diplosis atricornis* Walsh. (In gall of *C. s. strobiloides*.)
- 73. *Diplosis annulipes* Walsh. (In gall of *C. s. strobiloides*.)
- 74. *Diplosis septem-maculata* Walsh. In gall of *C. s. brassicoides* and *C. q. ficus*.)
- 75. *Diplosis decem-maculata* Walsh. (In gall of *C. s. strobiloides*.)
- 76. *Lonchaea*? (Raising blisters on twigs of willow. Figured and described in Packard's Guide to Study of Insects, 412.)

Order COLEOPTERA.

- 77. *Cotalpa lanigera* (Linn). (Brunswick, Me., June 23, Packard.)
- 78. *Hoplia trifasciata* Say. (Brunswick, Me., June 23, Packard.)
- 79. *Dichelonycha elongatula* Schönh. (Brunswick, Me., June 23, Packard.)
- 80. *Buprestis fasciata* Fabricius. (Mr. George Hunt informs us that he has found an elytron of this beautiful beetle under the bark of the willow in Northern New York in July. We have taken it in Northern Maine, and have always supposed that it inhabited the pine.)
- 81. *Chrysomela bigsbyana* Kirby. (Brunswick, Me., June 23, Packard.)
- 82. *Chrysomela spirea* Say. (Brunswick, Me., June 23, Packard.)
- 83. *Phyllodecta vulgatissima* (Linn). (Brunswick, Me., June 23, Packard.)
- 84. *Galerucella sagittariae* Gyllenhal. (Brunswick, Me., June 23, Packard.)
- 85. *Plectrodera scalator* (Fabr.). (On small swamp willows in August. Can. Ent., xii, 107.)
- 86. *Pachybrachys livens* Leconte. (Colorado River, California, on *Salix*, Leconte, l. c., p. 84.)
- 87. *Rhynchites æratus* Say. (Brunswick, Me., June, Packard.)
- 88. *Rhyncolus angularis* Leconte. (Under willow bark at New River, Colorado Desert. Leconte, Proc. Acad. Nat. Sci. Phila., March, 1858, p. 81.)

Order HEMIPTERA.

- 89. *Tingis hyalina*. (Maine, Packard.)
- 90. *Capsus* sp. (Also on alders. Maine, Packard.)
- 91. *Evacanthus orbitalis* Fitch. (Brunswick, Me., July 22, Packard.)
- 92. *Bythoscopus* sp. (Brunswick, Me., July 22, Packard.)
- 93. *Chaitophorus salicicola* Monell. (Is it *Lachnus salicicola* Uhler? Thomas, 8th Rep., 105.)

94. *Chaitophorus viminalis* Thomas. (On young twigs and leaves of *Salix lucida* and *S. babylonica*. Thomas, 8th Rep., 200.)
95. *Lachnus salicicola* Uhler. (*Aphis saliceti* Harris. Thomas, 8th Rep., 113.)
96. *Lachnus salicetis* Fitch. (Thomas, 8th Rep., 119.)
97. *Rhopalosiphum salicis* Monell. (On under side of leaves of *Salix lucida*, *S. nigra*, and *S. babylonica*. Monell.)

ACARINA.

98. *Acarus?* *semen* Walsh. (Producing galls on *Salix nigra* Walsh, Phila. Entomol. Soc., Phila., v.)
99. *Acarus?* *enigma* Walsh. (Producing galls on *Salix nigra* Walsh, Phila. Entomol. Soc., Phila., v.)

INSECTS INJURIOUS TO THE PINE.

Pinus strobus, *P. rigida*, etc.

AFFECTING THE TRUNK.

1. THE LARGE PINE FLAT-HEADED BORER.

Chalcophora virginiensis (Drury).

Order COLEOPTERA; family BUPRESTIDÆ.

Boring in the sap-wood and girdling the tree, a flat-headed, white grub; the track beginning as narrow and shallow grooves on the surface of the wood, forming irregular wavy or serpentine tracks, which gradually increase in width as the larva grows, ending in a large hole where the grub pupates; the beetle occurring on the leaves in spring and autumn.

The habits of this beetle in its preparatory stages are probably much like those of *Chrysobothris femorata*, which infests the oak, and the galleries which it makes under the bark are much like those of the oak buprestid. No thorough observations have been made upon the natural history of this beetle. It appears in the Northern States toward the end of May, and through the month of June, as Harris states, while we have observed it in Maine on pine trees the middle of July, and Fitch states that they occur upon the leaves of the pine in autumn. Harris says that in the larva state it bores into the trunks of the different kinds of pines, and is oftentimes very injurious to these trees.

The beetle.—Oblong oval, brassy or copper-colored, sometimes almost black, with hardly any metallic reflections. The upper side of the body is roughly punctured; the top of the head is deeply indented; on the thorax are three polished, black elevated lines; on each wing-cover are two small square impressed spots, a long elevated smooth black line near the outer, and another near the inner margin, with several short lines of the same kind between them; under side of the body sparingly covered with short, whitish down. Length 0.8 to 1.10 inch. (Harris.)

2. THE LIBERATED BUPRESTIS.

Chalcophora liberta Germar.

Very similar to the Virginian Buprestis, but always smaller sized, measuring from 0.75 to 0.90 in length, with the second raised line of the wing-covers broader than the first or inner line, and totally obliterated where it is crossed by the posterior impressed spot, its middle portion between the two impressed spots usually showing a few scattered punctures. (Fitch.)

This species is much more common in Eastern New York than the Virginian Buprestis, the beetle appearing upon the leaves of pines throughout the summer and autumn. From a small grove of young pines only a few rods in extent, upwards of a hundred specimens were taken the middle of last September, one or two being found upon almost every tree and bush; whilst only four individuals of the preceding and two of the following species were found in company with them. They had probably been bred in the numerous stumps of larger trees which had been cut down the year before by the side of this grove. They stationed themselves at the tips of the limbs, clinging to the leaves with their feet, with their heads inwards, their position, shape, and size giving them a close resemblance to the young aments or fruit cones which were growing from the same points on several of the limbs; and they appeared to be eating the young buds, which are probably the food on which all these beetles subsist after arriving at their perfect state. (Fitch.) This Buprestid is also found in Maine, but after several years' attempts we have not been able to clear up the habits of either species of *Chalcophora*, or to detect the larvæ.

3. THE OREGON BUPRESTIS.

Chalcophora angulicollis Leconte.

A beetle intimately related to the preceding species I met with in a collection of insects made at The Dalles, on Columbia River, many years since, by Rev. George Gary, of the Methodist Episcopal Church, and presented to me by the late Dr. Skilton, of Troy. Its close relationship to the species above described renders it altogether probable that its larva is similarly pernicious to the pine timber of the region where it abounds. And as no insect of this genus has hitherto been recorded as an inhabitant of that vicinity, that I am able to discover, I herewith submit a short account of its distinctive marks. (Fitch.)

The beetle slightly exceeds an inch in length, with the elevated smooth lines and spots, black and for the most part broader than the rough intervals between them, which are burnished brassy, tinged with coppery red. Its sculpture is very similar to that of the species last described above. The elevated line on the middle of the thorax is here twice as broad as in that species and at each end is rapidly, but not abruptly widened to double the breadth which it has in the remainder of its length, these widened portions having a few scattered punctures. Both at the apex and the base this widened portion is confluent with the irregular elevated stripes which are placed upon each side of the middle. The smooth pyramidal spots on the base oppo-

site the middle of the anterior end of each wing-cover are here larger and more prominent than in either of the foregoing species and each of these spots has the shape of a right-angled triangle, the line bounding its outer side running directly forward instead of obliquely inward and forward, each spot being also more broad than long. The rough depression which extends forward from these spots to the anterior angles of the thorax has in its middle a well marked, elevated, smooth spot, which is oblong and placed obliquely, with an oblique groove on its outer side separating it from a smooth and somewhat triangular spot on the outer margin, which is more distinct in this than in either of the preceding species, and produces a slight undulation of the outer edge, this edge being almost rectilinear with the opposite sides, parallel with each other two-thirds of their length, and then abruptly or angularly inclining inwards to the anterior angles. The wing-covers have the elevated lines much broken and irregular, resembling those of the preceding species, though on a particular examination several differences will be noticed. (Fitch.)

This insect has also been found by Dr. Leconte, at Sacramento, Cal.

4. THE TOOTH-LEGGED BUPRESTID.

Chrysobothris dentipes (Germar).

Though usually occurring in oak trees, occasionally living under the bark of the white pine, where it makes a flat, shallow burrow, sometimes half an inch broad and ending in an oval cell, in which the larva occurs in autumn, winter, and early spring.

We have already noticed this Buprestid among oak borers. We have found, May 20, at Providence, R. I., the dead beetle in its burrow under the bark of a white pine stump.

5. HARRIS'S BUPRESTIS.

Chrysobothris Harrisii Hentz.

Order COLEOPTERA; family BUPRESTIDÆ.

Appearing on the trees in May and becoming most common about the middle of June, a small beetle 0.32 long, of a brilliant blue-green color with black antennæ and feet, and in the male the sides of the thorax and the thighs copper-colored, its surface punctured, with a groove on the middle of the thorax and two indentations near the base of each wing-cover, slightly separated by a raised line, the inner one running into a groove which extends along the suture to its tip. Its larva living under the bark of young trees and small limbs. (Fitch.)

According to Leconte this beetle inhabits the twigs of the white pine. Mr. George Hunt also informs us that it inhabits the white pine in Rhode Island, where he has collected it late in June and during July.

6. *Chrysobothris trinervia* Kirby.

As this beetle occurs in the pine forests of Colorado, it is most probable that it bores in pine trees. It is a rather small, short, broad species, dull blackish, with faint metallic reflections. Surface of the body, especially the wing-covers, with irregular ridges, the inner one parallel to the inner edge of the wing-cover; wing-covers with smooth, elevated areas, between which the surface is minutely pitted with dense golden punctures. Body clothed beneath with short, coarse hairs. Length, 0.45 inch. (Leconte.) We collected a specimen on the Divide, Colorado, July 12. Prof. F. H. Snow has taken it at Santa Fé, N. Mex.

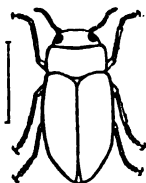


FIG. 64.—*Chrysobothris trinervia*. Colorado.—From Packard.

7. THE GOLDEN BUPRESTIS.

Buprestis striata (Fabr.).

Order COLEOPTERA ; family BUPRESTIDÆ.

Appearing upon pine and spruce trees in May and June, a brilliant and sparkling copper-red beetle, 0.55 to 0.70 long, its wing-covers marked with a broad brilliant bluish-green stripe on each and with four elevated smooth lines in which are several deep punctures, the two outer lines nearly or quite united at their hind ends and the exterior middle one a fourth shorter, the depressed spaces between these lines twice as wide as the lines and rough from coarse confluent punctures ; its thorax with a wide shallow groove along the middle, which is sometimes very slight, the surface covered with coarse punctures which become dense and confluent along the sides, as they are upon the head also, which has a slender elevated line along its middle ; the under side brilliant coppery. (Fitch.)

Like most of the other insect borers in the pine, it appears to be the dead wood of logs and stumps which this species prefers to living trees. T. B. Ashton informs me that he once found the fragments of one of these beetles in the interior of a pine log. I have met with it, in two instances, stationed at the tips of the limbs of young spruce trees in my yard, and it is probable that in its perfect state it feeds upon the tender young buds of the pine and the spruce. (Fitch.)

Mr. George Hunt tells us that it occurs on the white pine and yellow pine (*P. rigida*) in Northern New York.

Leconte states that it inhabits the Middle States, Canada, and the Lake Superior region. It varies in brilliancy of color ; the male is narrower than the female, and has the tip of the abdomen more distinctly truncate, or, rather, more broadly rounded.

Allied to this species is *Buprestis lauta* (Leconte), which is abundant in Washington Territory and Oregon ; while we have received it from Utah, through Mr. J. L. Barfoot, curator of the Salt Lake Museum. It has also been detected by Prof. F. H. Snow at Santa Fé, N. Mex. The male is a little narrower, says Leconte, than the female, but the tip of the abdomen is somewhat truncate in both.

Buprestis radians (Leconte) also inhabits Oregon. It is shaped like the male of *B. lauta*, but may be known by the very hairy front and prosternum. The tip of the abdomen is somewhat truncate.

Nearly allied to the two last named is *B. adjecta* (Leconte) from Oregon. It is said by Leconte to be broader even than the female of *B. lauta*, with intermediate elevated ridges on the elytra ; the tip of the latter is distinctly bidentate, while the abdomen is less strongly punctured and scarcely truncate.

8. THE ULTRAMARINE BUPRESTIS.

Buprestis ultramarina Say.

This species has been found by Fitch in the middle of July in a forest of pines and other trees, and is probably a pine insect. It is said by Leconte to be a broader form than *B. decora* Fabricius, to which it is

allied, with the intervals of the elytra less irregularly punctured, especially towards the suture, with the tips rounded, or hardly truncate, not bidentate as in that species. The abdomen is broadly rounded at the apex. The following description is quoted from Fitch's Fourth Report:

The Ultramarine Buprestis is half an inch long and of a brilliant green color tinged with golden yellow, the sides of the thorax being pure golden, with also a stripe along the middle where is a very slight wide groove, scarcely obvious. The wing-covers are brilliant blue, which color is margined on each side and at the base with golden yellow tinged with green, the suture and outer margin being burnished coppery red. On each wing-cover are about eight rows of large deep punctures placed closely together, and some of them united or confluent, and between each of these rows is a series of smaller round punctures. Their tips are cut off transversely, and on the side next to the suture is a minute projecting tooth. The scutellum is circular, deeply concave, and green, with its sides blue. The thorax is covered with close, deep, coarse punctures, which are more dense and confluent on each side. The head is rough from similar confluent punctures, with a slender, smooth elevated line in its middle. The antennæ are black with the basal joints coppery red. The under side is burnished coppery with the sutures of the abdomen green. (Fitch.)

9. SPOTTED-WINGED BUPRESTIS.

Buprestis lineata Fabricius.

A shining brassy-black beetle, sometimes blue-black or dark bottle-green, of the same shape with the preceding and 0.45 to 0.65 long, each wing-cover with from three to six pale tawny yellow spots of irregular shape and very variable, the mouth and throat often and sometimes the face of same color, and also a spot on each side of the last segment of the abdomen beneath, the wing-covers with several impressed lines and a row of punctures on each of the interstices between them, the thorax with coarser close punctures and a single large one on the middle of its hind edge. (Fitch.)

I have met with this beetle, in July, on pines growing at a distance from any other trees, an evidence that it had been bred from them. The spots on its wing-covers are extremely variable, being alike in no two specimens.

The more usual form is slightly larger, measuring 0.60 to 0.75 in length, and the wing-covers with two tawny orange stripes on each, the inner one of which is widest at its base and does not reach to the tip. Here also the last segment of the abdomen, beneath, has a tawny orange spot on each side, and the throat, mouth, and face, and a stripe on each side of the thorax are yellow, varied in places with red. (Fitch.) It occurs not infrequently in the Middle and Southern States according to Leconte. I have found, in company with Mr. Calder, the elytra of this beetle under the bark of the white and pitch pine, in Providence, R. I.

10. *Buprestis rusticorum* Kirby.

This is an abundant insect in the pine woods of Oregon and Washington Territory, and appears to range eastward into British America. We have found it in pine woods at Manitou, Colorado, July 16th, while it is not uncommon in New England, Mr. George Hunt finding it at

Providence, R. I. The body is brown, with an olive-green tint. Head and thorax punctured. Each wing-cover with five ridges, four of them well marked and smooth, the interspaces with scattered punctures. On the head between the eyes are five yellow spots; two simple dots, two long spots on the orbits, sending two projections outward, and a line in front sends three projections upwards. Two unequal yellow spots under the eyes. Labrum and labium yellow. Fine orange-yellow spots on each side of the end of the abdomen beneath.



FIG. 65.—*Buprestis rusticorum*, Colorado. —From Packard.

Length 0.65 to 0.92 inch. Leconte also adds that this species is nearly allied to *Buprestis maculiventris*, which occurs in the northeast from Pennsylvania to Newfoundland.

11. YELLOW-DOTTED BUPRESTIS.

Melanophila fulvoguttata (Harris).

Appearing upon pines in June, a more flattened beetle than the foregoing, 0.30 to 0.43 long, of a brassy black color with three pale yellow dots on each wing-cover placed towards the hind part and equidistant from each other, the hindmost ones nearest to the suture and the middle ones farthest from it; the fore ends of the wing-covers moderately rounded and fitting into corresponding concavities in the base of the thorax; the whole surface covered with shallow rough punctures running together transversely and somewhat resembling the grained side of morocco leather, and the thorax having an indentation on the middle of its base like the impression of the head of a pin. (Harris's Treatise, p. 44.)

12. DRUMMOND'S BUPRESTIS.

Melanophila drummondi Kirby.

This species, with *Buprestis rusticorum*, *Chrysobothris trinervia*, and *Dicerca prolongata*, we have collected in the pine timber of the mountains of Utah, in the American Fork Cañon, late in July, and it is probable that all will be found to inhabit the trunks of coniferous trees. It also inhabits Oregon and Washington Territory as well as Alaska and New Mexico, (Santa Fé, Snow.) Leconte describes it as being densely punctured, shagreened, with shining, metallic colors, especially on the prothorax, with three bright yellow spots on the posterior two-thirds of each wing-cover, the anterior spot being the larger. Length 0.40 inch.



FIG. 66.—Drummond's *Melanophila*, Colorado. —From Packard.

13. THE PITTED BUPRESTIS.

Dicerca punctulata Schonherr.

Occurring mostly upon the pitch pine (*Pinus rigida*); an obscure coppery or black beetle, half an inch long, convex above with the tips of

its wing covers tapering, and this narrowed portion more lengthened than in any of the foregoing species, their surface occupied with close fine punctures and double rows of coarse ones, the narrow spaces between these rows often elevated in places, the elevations forming smooth oblong spots or irregularly interrupted ribs; the thorax with coarser confluent punctures and with four elevated smooth stripes, the outer ones narrower and interrupted by a slight depression in the surface back of their middle; and finally, a smooth transverse elevation upon its front, extending from one eye to the other, is a mark whereby this species may be readily distinguished from most of those related to it. (Fitch.) I have found a dead beetle under the bark of the pitch pine in the same stump with *Buprestis lineata* in May, 1881, at Providence, R. I.

14. THE TUBERCULATED BUPRESTIS.

Dicerca tuberculata Laporte.

Another beetle which is met with upon the pitch pine, and resembles an individual of the preceding species of a more brassy tint and having all its marks more coarse, rough, and irregular; but the rows of coarse punctures on its wing-covers are at equal distances from each other instead of being in pairs, the intervening spaces having many irregular elevated black polished spots, and the elevated transverse line upon the front is interrupted and less prominent, and its size is rather larger, being about 0.60 inch long. (Fitch.)

15. THE SLENDER DICERCA.

Dicerca prolongata Leconte.

Although originally recorded by Leconte from Lake Superior, Wisconsin, and Nebraska, we have found this Buprestid among the pines and poplars in the mountains of Colorado, and are disposed to regard it as a pine beetle, though our specimen was found on a poplar tree.

It is described by Leconte as being coppery gray, often pruinose; the width of the thorax twice its length, sides well rounded in front, behind somewhat sinuous, punctate, furrowed, each side with an oblique, deeply impressed line; wing-covers with deeply impressed lines; apex rounded, the wing-covers scarcely divaricate. Length 0.77 to 0.85 inch.



FIG. 67.—*Dicerca prolongata*.—Colorado.—From Packard.

16. THE PINE DICERCA.

Dicerca tenebrosa Kirby.

Mining under the bark of the white pine, the beetle occurring in October. (G. Hunt.)

Leconte describes this beetle as follows: ashy-bronze or obscurely bronze, the prothorax dilated on the sides, which are rounded in front, sinuous behind, coarsely punctured; behind broadly excavated on each

side, with apical and basal shining smooth rugosities; a definite dorsal deep furrow with smooth sides, somewhat interrupted in the middle; elytra densely punctured, with alternate oblong, raised, shining interstitial spaces, prolonged entire to the apex; length, 0.57 to 0.75 inch. Male with the pectus broadly sulcate, villose; the intermediate tibiæ armed with an internal acute tooth; the last ventral segment truncate-emarginate. Female with the pectus smoother, less sulcate; the last ventral segment tridentate; the intermediate tooth obtuse, defined by minute incisions.

Abundant at Lake Superior; according to Kirby found in latitude 65° and in the Rocky Mountains. In addition to the characters given above, Leconte adds that the under surface is copper-colored, coarsely and densely punctured on the sides, abdomen and prosternum, less densely on the metasternum and middle of the first segment of the abdomen; the divided portions of the mesosternum are coarsely and tolerably densely punctured. The outer costæ of the thorax are interrupted so as to form on each side an apical and basal callosity. A female from Newfoundland differs by the epipleuræ being green, the under surface of the prolonged extremity of the elytra blue, and by the incisures between the anal teeth being more widely separated. (Leconte.)

Mr. George Hunt has found this beetle under the bark of the white pine in the Adirondack Mountains, New York, in October.

17. THE COMMON LONGICORN PINE-BORER.

Monohammus confusor Kirby.

Order COLEOPTERA; family CERAMBYCIDÆ.

Boring a hole, in outline round and regular, deep in the wood of sound, though usually in decaying, trees, and doing much injury to pine timber; a large, soft, white, fleshy, nearly cylindrical grub, the segment next the head larger than the others, flattened, horny and inclined obliquely downward and forward, the succeeding rings very short, with a transverse oval rough space on the middle above and below, pupating inside in the wood, the beetle emerging from a round hole half an inch in diameter; the beetle one of our largest longicorns, with very long antennæ; the body brownish-gray, the wing-covers spotted with black and white; length 1.20 inch.

Nothing was known of the habits of this borer by Harris, in the third edition of whose treatise the beetle is well figured. In 1860, Dr. Fitch gave an excellent account of the habits, and a brief description of the larva and pupa and adult, in his Fourth Report on the Noxious Insects of New York. The following description of the larva and pupa is based on specimens obtained at Brunswick, Me., and compared with some received from Mr. F. C. Bowditch, who published in the *American Naturalist*, August, 1873 (p. 498), an account of the habits and transformations. He sent me a block of pine wood split off, containing the terminal portion of the cell, stuffed with large chips arranged quite regularly. In the museum of the Peabody Academy of Science, at Salem, is a piece of planed plank, which had been sawn so as to uncover part

of the hole, with the beetle within, as seen in Fig. 69. Fitch states that this and *Monohammus scutellatus* and *marmoratus* are the most common and pernicious borers which occur in the pine timber of New York. On a still summer's night as well as in the day-time the peculiar grating or crunching noise which the larvæ make in gnawing the wood may be distinctly heard at a distance of eight or ten rods. "That the insect does not open a passage out of the wood, whereby to make its exit, until it attains its perfect state, I infer from the fact that several of these beetles gnawed their way out of one of the pillars of the portico of a newly-built house in my neighborhood some years since, the noise being heard several days before they emerged, and while they were still some distance in the interior of the wood." (Fitch.)

Mr. Bowditch found, June 9, at Brookline, Mass., this species in *Pinus mitis*, the yellow pine, in which were several holes about the size of a pencil. He makes the following statement in regard to its habits:

On removing the bark I found an adult insect already free—the heads of several others appearing through the wood. On further investigation during the next few weeks I obtained from the tree no less than eighty of these beetles in all stages of development, which, considering the size of the tree, was a large number. I observed that the largest beetles were near the foot of the tree. * * * After remaining in the pupa state during a space of time, which varies according to circumstances, it is transformed to a beetle, and after a short time gnaws its way out, appearing from the first of June to the middle of July.

I have found numbers, at least twenty of these larvæ under the bark of the white pine (*Pinus strobus*), at Brunswick, Me.,* in the early part of June, but no pupæ or beetles, though most of the larvæ were fully grown. Some were one-half an inch long and had, without much doubt, hatched from eggs laid in the preceding June or July, so that the larvæ must live nearly two years before transforming. My attention was called to their presence in the tree by the creaking sound made by the larvæ, the noise being heard a rod from the tree. Some of the larvæ were molting. In this process the entire head of the tegument about to be cast is pushed off anteriorly, while the thin skin of the rest of the body peels off from the prothorax backwards.

Mr. A. C. Goodell, of Salem, Mass., presented the museum of the Peabody Academy with an adult of this species which came from a pine bureau about the year 1875. The bureau had been in his house for about fifteen years previous, being newly made when purchased. The family had heard the creaking noise for some time before the insect appeared; and, after inquiring into the circumstances, I have no doubt but that the insect had lived in the bureau for fully fifteen years.

This longevity is probably due to the fact that the insect had not coupled, it being well known that continence in insects leads to the prolongation of life far beyond their natural term of existence. Further observations and experiments on this point are greatly needed.

* I have also found the cells under the bark of the white pine at Providence, R. I.

Ap[ro]pos of this interesting subject I quote the following observations of Dr. Fitch:

The wood of the apple tree was formerly highly valued for cabinet work in this country. In 1783, a son of General Israel Putnam, residing in Williamstown, Mass., had a table made from one of his apple trees. Many years afterward the gnawing of an insect was heard in one of the leaves of this table, which noise continued for a year or two, when a large long-horned beetle made its exit therefrom. Subsequently, the same noise was heard again, and another insect, and afterwards a third, all of the same kind, issued from this table-leaf; the first one coming out twenty and the last twenty-eight years after the trunk was cut down.

These facts are stated more fully in the History of the County of Berkshire, published at Pittsfield, in 1829, p. 39. This, I believe, is the longest period of an insect remaining alive in timber of which we have any record, and it is desirable to ascertain, if possible, what insect this was. John J. Putnam, esq., of White Creek, N. Y., was a young man residing at his father's when these remarkable incidents occurred. On showing to him specimens of all the larger long-

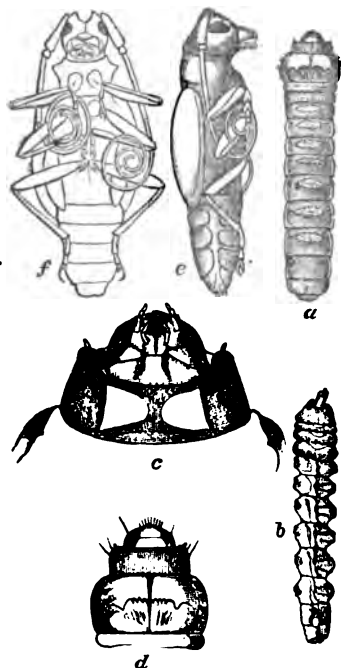


FIG. 68.—Larva of *Monohammus confusor*; a, top, b, side view, nat. size; d, upper, c, under side of the head; e, side, and f, under side of pupa.—From Packard in Hayden's Survey.



FIG. 69.—*Monohammus confusor*, the beetle in its cell in a piece of planed plank.—After Packard.

horned beetles of this vicinity, he points to *Cerasphorus balleatus* as being the same insect, according to the best of his recollection, but is not certain but it might have been the *Callidium agreste*.

"This testimony, in connection with what President Fitch, of Williams College, says of the insect in the notice above referred to—'its color dark glistening brown, with tints of yellow'—releases us from all doubts upon this subject, as the *agreste* is of a uniform brown, whilst the *bal. teatus* commonly presents traces, more or less distinct, of an oblique yellowish spot or band, near the middle of the wing-covers."

Larva.—Body soft, white, long, nearly cylindrical, being but slightly flattened, entirely footless, all the abdominal segments of the same width, except the minute small one. From the first abdominal segment (or fourth from the head), the body increases in width, being widest on the prothoracic segment (or the one next to the head). This segment is transversely oblong, being as wide in front as behind; it is a little more than twice as wide as long. The head is large and square, not narrowing

in front, but as wide anteriorly as posteriorly. When the head is forcibly pulled out it is found to be as long as broad; anterior one-fourth of head, deep mahogany red, becoming blackish on the edge. Clypeus very short and broad, about four times as broad as long. Labrum rather wide, not much contracted at base, rounded in front, with very stout bristles on the margin. Mandibles gouge-like, the ends oblique, hollowed out, with the outer edge produced into a point. Antennæ very minute, three-jointed, the second and third joints about as long as the basal. The maxillæ form a basal joint, throwing off a three-jointed palpus, and an inner lobe armed with stiff bristles, reaching to the end of the second joint of the palpus. The two-jointed labial palpi reach to as far as the middle of the brush-like lobe of the maxillæ; the second joint is about as long, but half as wide, as the basal. The middle of each segment, especially the third to the seventh above and below, with a transverse callous spot. The upper side of the first abdominal segment has a very narrow oblong square area impressed upon it. The callous spot is best marked on the fifth segment, consisting of an area about one third as long as broad, with a square, shallow sinus posteriorly, and with the sides projected inwards; it consists of two series of callous spots, the outer forming the limits of the area as above described, and the inner series forming a simple transverse, narrow, lanceolate, oval spot. The callous spot on the under side has a sinus in front, but slightly rounded behind. The one on the seventh segment (below) is but little more than one-half as wide, with a broad sinus on the hind edge, and with the sides directed obliquely inwards. Terminal segment very small, half as wide, and one-fourth as long as penultimate segment. Nine spiracles, the first on front edge of second thoracic (mesothoracic) segment. Length when fully grown, $1\frac{1}{2}$ inches.

This larva may be known from that of *Rhagium lineatum* by its lack of any thoracic feet and by its much longer, more cylindrical body, and differs at once by the long, square head, that of *Rhagium* rounding in front; by the wider clypeus, and proportionately wider and shorter labrum. The palpi and antennæ do not differ much. The callous spots on the abdominal segments are smaller and otherwise different from those in *Rhagium*.

Pupa.—The pupa is far advanced, being nearly ready to change to a beetle, the body becoming dusky and horn-colored, while the characteristic dark spots have already appeared on the wing-covers. The antennæ are coiled up three and a half times at the end between the fore and the middle pairs of legs, and the genus may be recognized by their great length and the deep excavation in the head between them, as well as by the lateral short spine on the prothorax.

The wing-covers in my single specimen reach to the third abdominal segment, and are pressed obliquely to the side of the body. The salient portions of the upper side of the abdominal rings with fine spines. End of the body sinuate.

In the absence of another pupa of this genus for comparison, additional characteristics cannot now be given. Length, $\frac{3}{4}$ of an inch.

Mr. George Hunt has taken both this species and *M. scutellatus* "coming out of the white pine" in July in northern New York and in Rhode Island. Prof. F. H. Snow records it in the seventh volume of the Transactions of the Kansas Academy of Science as occurring in the Baptist church in Lawrence, Kans., "where repairs had been made with pine lumber."

15. MARBLED PINE-BORER.

Monohammus marmoratus Randall.

A large white grub very similar to the last preceding one, and boring in the interior of the wood, often in the same trees and logs with it. The beetle coming abroad in July and very similar to the preceding, but always smaller, measuring 0.75 to 0.90 in length, and distinguished from it by having the short hairs coating the base of the spine on each side of the thorax of an other yellow color instead of white, the thorax with numerous confluent punctures across its middle, its wing-covers ash gray marbled with tawny brown cloud-like spots, and punctured like the preceding species, but the punctures here becoming much more dense towards the base and running into each other, the antennæ in the females with an ash-gray band at the base of each joint, their length in the two sexes as in the preceding species. (Fitch.)

This is not a particularly common insect, though more closely allied to the foregoing species than the following better known one.

16. THE WHITE-SCUTELED PINE-BORER.

Monohammus scutellatus Say.

A large white grub closely like the foregoing and boring in the wood in a similar manner, in the month of June producing a beetle of similar form but of a shining black color, its wing-covers having small patches of short hairs here and there, resembling spots of white mold, their surface rough from coarse confluent punctures and the thorax similarly punctured across its middle, its base and apex with irregular transverse wrinkles, and its sides with a conical spine which is not clothed with hairs, the scutel coated over with white hairs, and the antennæ double the length of the body in the males, and in the females with a gray band on the base of each joint, its length varying from 0.60 to 0.75. (Fitch.)

This is a common and sometimes abundant beetle in Maine and Northern New England generally, and especially in the lumber regions of Lake Superior, whence I have received it in large numbers. It also occurs in the pine forests of British America and in Washington Territory and Oregon along the Pacific coast. Though I have taken it on the white pine (Maine) in July, I cannot relate more concerning its habits and larval forms than is contained in Dr. Fitch's brief account given above.

17. THE PINE-EATING GAY-BEARD.

Eupogonius pinivora Fitch.

Order COLEOPTERA; family CERAMBYCIDÆ.

A small grub resembling a young apple-tree borer, mining the wood of the pine, and in July becoming a small cylindrical long-horned beetle, which is found upon the leaves, 0.25 long and about a third as broad, clothed with numerous erect black hairs

on the body and antennæ, and gray ones on the legs; its color shining pale chestnut, with irregular oblique and transverse spots and streaks of gray on the wing-covers, which are coarsely punctured, the punctures dense on the base and fine on the apex; its thorax narrower, slightly darker colored, closely punctured, having a very small tooth-like point on each side and along its middle a gray line which is widely interrupted in the center, the sides and also the head with thin gray pubescence; its antennæ shorter than the body, coarse, and the joints becoming suddenly shorter after the fourth; its under side blackish brown, the legs pale chestnut.

This species is of the same color with *E. tomentosus* of Haldeman, which, however, is larger, with gray hairs instead of black, and the wing-covers with ochre-yellow spots and streaks. (Fitch.)

18. THE COMMIXED LEPTOSTYLUS.

Leptostylus commixtus Haldeman.

Order COLEOPTERA; family CERAMBYCIDÆ.

A small long-horned beetle occurring on the leaves of the pine in July, its appearance and shape closely like that of the prickly *Leptostylus* No. 4, Plate 1, Fig. 4, and its larva probably having similar habits and the same form; the beetle 0.25 to 0.36 long, its thorax closely punctured, blackish obscurely varied with ash-gray and with elevated black dots placed symmetrically, the sides convex and with a small angular tooth back of their middle; its wing-covers coarsely and closely punctured, dull and gray varied with paler gray and with black clouds and dots, two faintly elevated ribs on each wing-cover of a slightly paler gray tint alternated with black dots, the inner rib having an elongated black spot near its base, another beyond the middle, and a third one farther back, formed by obscure dusky transverse clouds which cross the ribs at these places; the sides black, alternated with a whitish cloud-like spot near the base, and a smaller one near the middle. (Fitch.)

19. THE LESSER PINE-BORER.

Asemum mastum Haldeman.

Order COLEOPTERA; family CERAMBYCIDÆ.

Perforating the trunk of the white pine in all directions and sinking into the heart of the tree, making a flattened cylindrical hole or mine when seen in outline; a rather small larva, which emerges late in May through oval holes in the bark, especially around the base of the trunk; the beetle blackish brown with short antennæ and legs.

The transformations of this common borer, which apparently attacks the tree in health as well as in disease, like the species of *Monohammus*, were first briefly described and figured in our "Guide to the Study of Insects" from specimens found in all stages under the bark of the oak early in May at Salem, Mass. I have also received a larva of this species from Dr. Shimer, which was found by him boring in the grapevine. Since then Mr. Riley has bred it from the Scotch pine, and Mr. Schwarz has found the pupa under the bark of pine stumps in Florida

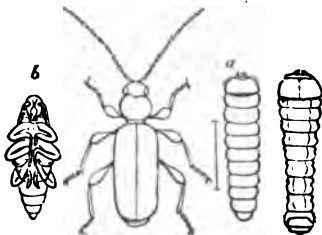


FIG. 70.—a, Larva; b, pupa and beetle (enlarged twice) of the lesser pine-borer.—From Packard.

in March. During the past May I have found, in company with Mr. Calder, at Providence, the perfect beetles, and also the pupa in deep burrows or mines in white-pine stumps. I have heretofore regarded the holes made by this borer as probably those of *Chalcophora virginiensis*, but they are regularly oval cylindrical, less flattened oval than those made by a Buprestid, and exactly like those of other flat-bodied longicorns. The openings perhaps more abundant on the south side of the tree or stump, in the base of the trunk of the white pine, are at times very numerous, as many as ten in a space of 5 square inches. They are, on the average, 6^{mm} wide by 3^{mm} deep, or half as deep as wide. The sides are smooth, but the orifice is often partially concealed by projecting portions of the bark. The holes are deep, extending 6 or 8 inches towards the heart of the tree. Seen longitudinally the "mine" or tunnel is about a quarter of an inch (6^{mm}) wide, sometimes wider, and ends in an elongate oval cell, wherein the pupa rests. Some extend up and down under the bark, while most plunge deep into the wood.

The larva.—We have not specimens at hand for elaborate description, but those found in the oak were footless, white, with a rather large prothorax, in which the head sinks, with strong black jaws; the body is quite uniform in thickness, gradually diminishing in width posteriorly. It is .60 inch in length.

The pupa is .44 inch long. It is flattened and rather broad, and may be readily identified from the other pupæ of the genus, as it has the characters of the species, viz, by the short antennæ, which do not extend quite as far as the hinder edge of the metathorax, the joints composing it being much shorter than in the other species. It may also be recognized by the two raised longitudinal lines on the wing-covers corresponding to those on the wing-covers of the beetle; the wing-covers extend to near the middle of the second abdominal segment, and the tips of the hind legs reach nearly to the posterior edge of the third abdominal segment. The end of the abdomen is square, and ends in two sharp, slender incurved hooks, which are dark red at tip. Length, .44 inch.

The beetle differs from two larger common beetles (*Criocephalus agrestis* and *obsoletus*) with which it associates, by its much smaller size, which, however, is very variable, and by the much shorter antennæ, the joints being much shorter and thicker and more coarsely pitted than in the two species above named. It is brown-black, with a rounded, flattened prothorax, and two longitudinal ridges along the wing-covers.

I have taken this beetle at Nederland, in Colorado, June 30; it undoubtedly preys upon coniferous trees in the Rocky Mountain region. It is also said by Leconte to occur in Russian America (Alaska).

20. *Criocephalus agrestis* Kirby.

Boring into pines from Maine to Colorado and the Pacific coast, a rather large white longicorn larva; assuming the pupa state in May and the beetle state in June and July.

This large beetle closely resembles *Asemum moestum*, but is about twice as large, with much longer and slenderer antennæ; it is also characterized by the three large irregular pits on the top of the prothorax; these pits are also seen in the pupa, and by them the pupa noticed below was identified as belonging to this species. In color and the two

high ridges on each wing-cover it closely resembles the more abundant *Asemum moestum*.

I found what I regard as the pupa of this species under the bark of the pitch-pine at Providence, May 20, 1881. From its close resemblance to the pupa of *Asemum moestum*, from the form of the prothorax and the three pits which correspond so closely to the beetle, I do not doubt but that the pupa should be referred to *C. agrestis*.

The antennæ of the pupa are long and reach to the basal sixth of the wing-covers; they thence recurve, so that the tip touches the basal third of the fore tibiæ. The end of the abdomen has two spines, much as in the pupa of *Asemum moestum*; the wing-covers have each two longitudinal parallel straight raised lines, while the body in general is flat and rather broad, as in the beetle. The pupa is 25^{mm} in length; breadth of body, 7½^{mm}.



FIG. 71.—*Criocephalus productus*.—From Packard.

Criocephalus productus Leconte (Fig. 71) I have taken in Colorado, and in Utah, and I have received it from Tacoma, W. T. on the shores of Puget Sound. It undoubtedly inhabits pine trees, and represents the Eastern *C. agrestis*.

21. *Edilis nodosus* Fabricius.

Found under the bark of the pine from June to September. The specimens collected about Philadelphia are quite small compared with those found in the pine forests of New Jersey. (Bland, Proc. Ent. Soc. Phil., i, 97.)

22. *Edilis obsoletus* Olivier.

Taken under the bark of pine stumps at and near Philadelphia. Not common. (Bland, l. c.)

23. THE PINE EUDERCES.

Eudercus pini Olivier.

Order COLEOPTERA; family CERAMBYCIDÆ.

A small cylindrical long-horned beetle, having a wide separation between its thorax and abdomen, giving it some resemblance to an ant, 0.23 to 0.30 long, of a bright chestnut color, with its abdomen and the posterior third of its wing-covers black, the wing-covers crossed obliquely forward of their middle by a silvery white line which does not reach to the suture, and posteriorly on the fore part of their black portion a gray band, which is placed in a shallow groove running obliquely and parallel with the silvery line; the thorax covered with fine impressed lines running lengthwise.

This is said by Olivier to have been found on pines around the city of New York but it is probably a Southern insect. (Fitch.)

24. BLACK-HORNED CALLIDIUM.

Callidium antennatum Newman.

Order COLEOPTERA; family CERAMBYCIDÆ.

A flattened long-horned beetle, appearing in May and June, about 0.52 long, of a deep Prussian blue color, often with shades of green in places, its antennæ and legs

black, its thorax hairy, and as broad as the wing-covers, with the sides strongly rounded and above on each side of the middle a little round hollow spot, and its wing-covers rough from close shallow punctures. (Fitch.)

Dr. Harris regarded this as identical with the European *C. violaceum*, deeming the latter to have been probably introduced into Europe from this country. (Treatise, page 88.) But entomologists now consider the insects of the two continents to be distinct species. Ours, doubtless, has the same habits with that of Europe, the larva living in the trunks of pines, excavating a wavy shallow track under the bark, which is packed full of sawdust, and when almost fully grown, sinking itself obliquely downwards several inches into the wood, to repose during its pupa state.

Specimens occur in which the thorax is plainly narrower than the wing-covers, more distinctly punctured, and destitute of the two impressed spots. These are the violet-colored *Callidium*, *C. janthinum* of Dr. Leconte and of Dejean's Catalogue. But individuals appear to occur of all intermediate varieties, and I am therefore inclined to think they can scarcely be regarded as constituting two distinct species. (Fitch.)

We have observed this in considerable numbers under pine boards, and also flying, at Brunswick, Me., in the middle of May. Mr. George Hunt has observed it in pine trees at Providence, R. I. We found at Providence, May 14, a dozen or more individuals under the bark of a dead *Juniperus virginiana*. The track made by the larva, as we supposed it must have been of this insect, was irregularly wavy, like that of other longicorn grubs, and filled compactly with a fine dust, its castings; it was shallow and 4 or 5 inches long. Whether it was made before the death of the tree is unknown, but the work of this and its fellows had loosened the bark, several larvæ having been at work together.

25. THE PORTER HYLOTROPES.

Hylotropes bajulus Linnaeus.

Order COLEOPTERA; family CERAMBYCIDÆ.

A beetle very similar to the preceding in its shape and habits, appearing in July and August, 0.45 to 0.75 long, of a black color, its thorax nearly circular and clothed with white hairs, with a smooth polished black line in its center, and a callous-like spot on each side of it, and its wing-covers with very coarse, shallow confluent punctures and some downy whitish spots, forming two irregular bands near the middle.

This species is supposed to have been introduced in its larva state in timber from Europe, and is found in our country only near the sea-coast. (Harris's Treatise, page 88.)

26. THE LESSER PRIONUS.

Orthosoma brunneum De Geer.

Order COLEOPTERA; family CERAMBYCIDÆ.

A flattened long-horned beetle, 1.00 to 1.30 long, and less than a third as broad, with its opposite sides parallel, its thorax twice as broad as long, and with three sharp

teeth on each side, its wing-covers with two or three slight elevated lines, its antennæ scarcely as long as the body, and its color chestnut red, darker anteriorly.

Larva.—Described while alive. Body cylindrical, not flattened, the segments very distinct, as the sutures are deeper than usual; head moderately broad; prothorax large and broad and rather long, being 9^{mm} broad and 4½^{mm} long; surface rough on the posterior two-thirds. On each of the 1st to 7th abdominal segments is a transverse oval, cylindrical fleshy area, each with three transverse folds, the area on the 7th ring being nearly twice as long (antero-posteriorly) as that on the first; the areas becoming longer and narrower; *i. e.*, more rounded, going backward towards the 7th segment; the end of the abdomen smooth and shining; each thoracic segment with a pair of slender 3-jointed feet. Length, 35^{mm} (1½ inches). Two dozen or more were taken May 26 by Mr. Calder and myself from a very soft, rotten pine stump; up to June 24 they had not pupated in confinement, but by the 5th to the 8th of July one of them became a pupa.



FIG. 72.—The lesser Prionus. Natural size.—After Riley.

Pupa.—Antennæ bent near their end at right angles and laid across the end of the elytra, the latter reaching to the middle of the hind tarsi. End of the abdomen terminates in a singular ruffle-like expansion, armed on the edges with stout spines. Hind tarsi reaching to the middle of the 5th abdominal segment. The body considerably curved. Maxillary palpi extended well beyond the end of the mandibles. Prothorax with a broad-based spine on the side. The projecting parts of the abdominal segments with fine spines, and segments 3 to 5 with a pair of transverse, thin, dark-brown, chitinous patches. Length, 30^{mm}.

Mr. Calder has also found the fully grown larvæ in August in maple logs at Warwick, R. I., and in the rotten wood of another deciduous tree. So that it appears that this beetle lives indifferently in the soft, decayed logs or stumps both of hard and coniferous trees.



FIG. 73.—*Prionus emarginatus*.—From Packard.

27. PRIONUS EMARGINATUS Say.

Probably injuring shade or timber trees in Utah, a dark brown beetle of the following appearance:

Body castaneous; head, thorax, and breast covered with long yellowish ferruginous hair; antennæ fourteen-jointed, glabrous, perfoliate, imbricate; the imbrications emarginate beneath; mandibles black at tip; thorax but slightly margined, one-toothed on the middle of the lateral edge; angles obtusely rounded; elytra somewhat unequal, punctured; feet and venter subglabrous. Length nearly seven-tenths of an inch. Female glabrous; antennæ simple. Length, four-fifths of an inch. This species exhibits the general form of *brevicornis*, but the thorax is proportionally much

narrowed, and the characters above detailed prove it to be very distinct from that species. The lepaceous processes of the antennæ are so profoundly emarginate beneath as to appear each bilobate. I obtained it on the Arkansas River near the mountains. (Say.)

28. *Ergates spiculatus* Leconte.

Bores in *Pinus ponderosa* in Colorado. (A. S. Fuller. Amer. Ent., iii, 238.)

Cryocephalus nubilus Leconte.

Larva boring in roots of yellow pine (Tampa, Fla.), the beetle appearing in April. (E. A. Schwarz. Amer. Ent., iii, 238.)

29. HARRIS'S PRIONUS.

Tragosoma Harrisii Leconte.

Order COLEOPTERA; family CERAMBYCIDÆ.

A beetle closely resembling the preceding, but with much shorter antennæ, only one tooth on each side of the thorax, and several raised lines on the wing-covers.

This rare insect, which has only been found hitherto in New England and Newfoundland, inhabits New York also, and I infer it to be bred in the pine, having in one instance met with the beetle, dead, under the loose bark of one of these trees. (Fitch.)

"A specimen of this species was found by Mr. Gibbs east of Fort Colville [Oregon]. It probably extends its range across the continent in more northern latitudes." (Leconte, Proc. Acad. Nat. Sc. Phil., Nov., 1861, p. 354.) Mr. George Hunt has collected it among the pine forests of the Adirondacks, Northern New York.

30. THE RIBBED RHAGIUM.

Rhagium lineatum Olivier.

Order COLEOPTERA; family CERAMBYCIDÆ.

Common in the pitch-pine, several often in the trunk of the same tree, excavating a broad irregular patch in the outer surface of the sap-wood, the cavity being mostly filled with sawdust; a yellowish-white grub about an inch long, divided into segments of nearly equal length and width, except the second which is the broadest, and the last which is narrowest with its end rounded; surrounding itself with a broad oval ring of woody fibers, like short threads, placed between the bark and the wood, in which to pass its pupa state; changing to a beetle, which lies in the same cell through the winter and comes abroad in the spring; the beetle 0.40 to 0.70 long, long and narrowish, its head and thorax much narrower than the wing-covers, cylindrical, clothed with soft gray hairs upon a black ground, the thorax with a black stripe above and one on each side, where is also a stout spine; the antennæ only reaching the base of the wing-covers, which are dull yellowish gray variegated with black, each with three elevated lines, the outer two uniting at their tips. (Harris's Treatise, page 102.)

We have found the beetles and pupæ of this beetle under the bark of a white pine log, at Salem, Mass., in abundance in October, and have also detected it frequently in Maine in the same situations in the spring, April 24, both in the larval and adult state.

Larva.—It may be readily recognized by having three pairs of long and slender thoracic feet, which are 3-jointed, ending in a long claw, as well as by the broad, flat body, the end being broad and rounded. The prothorax is large, transversely oblong, not quite so wide, but nearly as long as the three succeeding segments. A pair of spiracles on the mesothoracic segment, and the usual ones on the abdominal segments. Length, 12^{mm}; breadth, 4^{mm}. Described from one found May 26, at Providence, under the bark of the white pine.

The cell in which the larva rests during the winter, and in which the pupæ and beetles reside, is irregularly oval, about 2 inches long and one-third as wide, very shallow, and partly surrounded by a wide border of closely packed chips gnawed off from the wood; and partly by the excrement or reddish sawdust-like closely packed material, derived originally from the inner part of the bark. The entire cavity is thus about 4 inches long and 2 wide, and very irregularly oval in outline. It seems probable that this larva does not make a regular wavy burrow, but remains in one spot, eating out in all directions from a comparatively fixed point; in this respect it differs from many other *Cerambycid* larvæ.

31. WOOD-ENGRAVER BARK-BEETLE.

Xyleborus xylographus Say.

Order COLEOPTERA; family SCOLYTIDÆ.

In the outer surface of the sap-wood and inner layers of the bark, mining a long slender thread-like track, usually straight, lengthwise, 4 to 8 inches long, from which numerous smaller short tracks branch off mostly at right angles; a small bark-beetle 0.12 long, which comes abroad mostly in May, of a chestnut color, the declivity at the tip of its wing-covers having four or five minute projecting teeth upon each side. (Fitch.)

This, like other bark beetles, has a compact cylindrical body at least three times as long as broad, with the thorax forming almost half of the entire length, and having the head deeply sunk in its anterior end and almost hid. Their antennæ are quite small, and are composed of a long basal joint, which becomes thicker towards its tip, and is followed by five very small joints, surmounted by a large, round, flattened club, which is divided by sutures into three or four segments.

This species is glossy and bearded with fine hairs. Its thorax is shagreened anteriorly with minute elevated points, which farther back become less dense, and the basal half is covered with fine punctures, with a smooth line above along the middle from the center backwards. The wing-covers have rows of coarse punctures and minute ones on the interstices between these rows, and their tips are abruptly declined as though cut or gnawed off, the outer margin of this declivity having four or five small projecting teeth upon each side. It is usually chestnut colored, with the antennæ and legs paler, but individuals may be met with of the following varieties:

Variety *a*, *nigricollis*. Thorax black.

b, *niger*. Thorax and wing-covers black.

c, *fulvus*. Thorax and wing-covers pale yellowish.

The wood-engraver bark-beetle is the most common and probably the

most pernicious of all the insects infesting the forests of white pine in the State of New York, and of yellow pine (*P. variabilis*) in the States south of us. Whilst it is old and decaying or dead trees that most of the larger borers which we have described above attack, this small insect is liable to invade trees that are in full health and vigor, those that are young as well as old, mining beneath the bark and loosening it from the wood, so completely separating it that it breaks off in large pieces. Frequently, on elevating this loosened bark, its inner layers and the whole outer surface of the wood are found plowed in every direction, and the furrows are so intricate and confused that it is impossible to follow the track which any one individual has traveled. But in places where they have been less numerous, the work which each insect has performed is distinctly marked and is so regular and artistic in its appearance as to have suggested to Mr. Say the name of the wood-engraver as a most appropriate designation for this beetle. The cut on the following page is an exact copy of the tracks made by one of these beetles and its young, their natural size.* It will be seen to consist of a main central track running nearly straight, from which numerous smaller short ones branch off at nearly right angles. Though I have not observed the habits of these insects sufficiently to be perfectly certain respecting all the points in their operations, the course they pursue in forming these tracks appears to be as follows: The female having selected a situation which will furnish suitable sustenance to her young, bores through the bark to the outer surface of the wood, and then mines a passage between the bark and the wood, in a straight line lengthwise of the tree or limb where no obstructions occur to cause her to deviate from her course. The male probably accompanies her and shares with her in this labor, each working by turns. Thus a long slender cylindrical gallery is formed, which is excavated about equally in the outer surface of the wood and in the inner layers of the bark. In some instances, two, three, or even six tracks will be seen to start from one point, running in opposite directions; but always lengthwise of the tree or limb, and with lateral branches so similar to those in the figure, that I am in doubt whether they are the work of this or one of the other species which belong to this tree. Upon each side of the main track, little notches are excavated at intervals, whilst the work is in progress, similar to those represented in our figure of the tracks of the pinebark-beetle on the succeeding page, though larger than those, being about equal to the width of the track in their length, but less in their width, and having their outer ends evenly rounded. In each of these notches from one to four eggs are placed. And as the beetles mine their way onwards, the fine dust which they form probably becomes strewed along the track behind them. Then, as they travel backwards and forwards in the burrow from time to time, the little stiff hairs with which their bodies are bearded, serve as a brush to sweep this dust into these lat-

* The cut is not reproduced.

eral openings. Thus the mouths of these notches become filled and the eggs therein covered and concealed from any predaceous insect which may enter the burrow after the parent has completed her work and before the eggs have hatched and the young have mined their way beyond the reach of such enemies. The female continues her operations until her stock of eggs is exhausted, forming a burrow from 4 to 8 inches or more in length.

The eggs of this beetle are about 0.025 long, of a broad, oval shape, and a watery white color. They may be met with in their newly formed burrows beneath the bark, the fore part of June. They probably hatch in ten to twenty days, according to the temperature of the atmosphere at this time. The infantile larva is invariably found lying with its back towards the sawdust with which the notch in which it is bred is filled, its mouth being thus brought in contact with the soft innermost layer of the bark at the extremity of the notch—the elastic nature of the sawdust probably aiding in pressing its mouth against its destined nourishment. Thus it has only to part its jaws and close them together again to fill its mouth with food. And by repetitions of this motion a cavity is gradually formed between the bark and the wood, into which its head sinks, and afterwards its body. This cavity consequently takes a direction outwards at right angles with the central burrow. And thus the larva eats its way onward until it has obtained its growth, forming hereby a gallery varying in its length from about one to three inches, as the material consumed has been of a quality more or less nutritious, and winding and turning where impediments have been encountered or the track of another larva has been approached. Many of these lateral galleries, however, end abruptly before they are half completed, the worm having been destroyed by insect enemies or some other casualty. And it is curious to notice how these little creatures respect the territory which is already in possession of another, changing their course to avoid any encroachment thereon; and if one of them finds himself so surrounded and hemmed in by other tracks that it becomes impossible for him to refrain from encountering them, he so shapes his course as to cross his neighbor's road as nearly as possible at right angles instead of obliquely, thus intruding thereon as little and for as short a time as possible. Sometimes also two females happen to excavate their galleries parallel with each other, and so near that no adequate space remains between them for their young to mine their burrows, the beetles having been unaware of their proximity, no doubt, until too much labor had been expended to admit either one to abandon the ground and go elsewhere. In such cases the eggs are all placed along the outer side of each gallery, and thus the larvæ all mine their way outward in opposite directions to each other.

The larva is a plump soft white worm, broadest anteriorly, and with its body bent into an arch or having its tail turned partially inward under the breast. By transverse impressed lines it is divided into

thirteen segments, the head being counted as one. Its head is polished and white, at least during the first periods of its life, with its mandibles chestnut brown, and no indications of eyes, and no feet, but with their places supplied by two small round retractile teat-like protuberances on the under side of each of the three segments next to the head. Having completed their growth, they sink themselves into the wood to repose during their pupa state. The small round hole which they perforate in the wood for this purpose, is seen at or near the outer end of each burrow in which the worm has lived to reach maturity.

The pupa resembles the perfect insect in its size and shape, with the rudimentary legs and wings inclosed in sheaths and appressed to the outer surface of its body in front. After taking on its perfect form it perforates a small round hole through the bark and comes out from the tree.

This and the other bark-beetles of the pine have numerous insect enemies which wage incessant war upon them. Various species of small beetles pertaining to the families *Staphylinidae*, *Histeridae*, &c., are always to be met with under the loose worm-eaten bark of pines, and M. Perris has ascertained that these insects resort to this situation for the purpose of rearing their young, their larvæ being predaceous and subsisting upon the larvæ and pupæ of the bark-beetles. (Fitch.) We have found this species common under the bark of pines in Maine, the beetles flying in April and May.

31. THE FINE-WRITING BARK-BEETLE.

Tomicus calligraphus Germar.

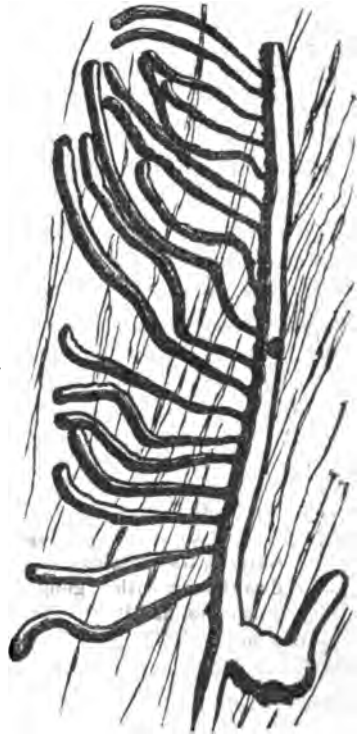
Under the bark of the pitch pine and other species of pine, mining long, and often zigzag tracks lengthwise of the tree, these tracks having short, coarse, irregular branches; a chestnut-brown bark-beetle 0.18 to 0.22 long, clothed with numerous yellowish gray hairs, its thorax rough anteriorly from close elevated points, and punctured posteriorly, its wing-covers with rows of coarse punctures, their tip broadly excavated as though with gouge-chisel, the surface of this excavation rough from coarsish punctures, and its margin on each side with five or six small unequal teeth. Appearing mostly in the month of May. (Fitch.)

This species was originally named *exesus*, or the excavated bark-beetle, in allusion to the tips of its wing-covers, in the old Catalogue of Rev. F. V. Melsheimer, under which name a short account of it was published by Mr. Say, in the year 1826. Germar, however, had described it two years before, under the name *calligraphus*, meaning elegant writer, which name it must retain, although not happily chosen, the tracks which this beetle forms under the bark being coarse, irregular, confused, and far less beautiful than those of many of the species of this genus.

It is in the pitch pine that this beetle mostly occurs in the State of New York, but I have also met with it in the limbs of aged white pines, and farther south it is common in the yellow pine. Its burrow is somewhat like that of the preceding species, consisting of a single long fur-

row extending lengthwise of the tree or limb, from six to twelve inches in length, but it is less straight in this species, being usually curved more or less, and according to accounts it is often perfectly zigzag. The same notches are formed along its sides as noticed in the foregoing species, in which the eggs are deposited; but the lateral burrows which branch from the central one have no regularity whatever to them, being given off sometimes obliquely and sometimes at right angles, sometimes abruptly widening into a broad irregular, flat cavity, and sometimes continuing of the same width through their whole length, either straight, irregularly wavy or tortuous, turning here and there, wherever an unoccupied space occurs into which they can be extended. These branches are usually of the same width with the central gallery, and like it are furrowed equally deep in the outer surface of the wood and the inner surface of the bark. The pupa state is passed in a cell excavated in the bark, and not in the wood, as in the foregoing species, and when changed into a beetle this cell is extended onwards through the bark for the escape of the insect. Being a larger species than the preceding, the galleries which it excavates, and the holes it perforates through the bark, are proportionally larger. Several dead individuals may usually be found in the galleries of this as of the other species. (Fitch.)

I have found the "mines" or galleries of this bark-borer under the bark of the southern pitch pine at Houston, Tex., where it seemed to be abundant. Beetles taken from the mines were sent to Dr. G. H. Horn, who kindly identified them as *T. calligraphus*. Fig. 74 represents a typical mine. It consists of a primary or main gallery or mine which is $3\frac{1}{2}$ mm wide; the holes for the exit of the beetle, of



which two are represented in the engraving, being 2 mm in diameter. The primary gallery is nearly straight, with, in the cases noticed by us, only one set of secondary galleries arising on one side, as represented in the figure. The secondary galleries are from one to nearly two inches in length, and at the end a little over half as wide as the main gallery. At one end the main gallery opens into a broad irregular cell, where the worm probably transforms into the pupa, connecting with the hole for the exit of the beetle.

Another form of cell without any lateral or secondary galleries is

FIG. 74.—Mine of *Tomiscus calligraphus* in southern pitch pine, Houston, Tex. Packard del.

represented at Fig. 75. The arrow indicates a point in the gallery made when the larva was small. A specimen taken from this mine was also submitted to Dr. Horn for identification. It occurred under the bark of the southern or yellow pine at Atlanta, Ga., where I collected it in April, 1881.

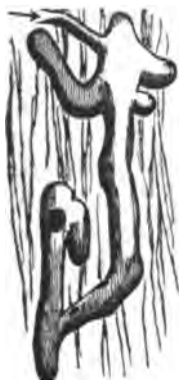


FIG. 75.—Primary mine of *Tomicus calligraphus* in yellow pine, Georgia. (Packard del.)

33. THE SOUTHERN TOMICUS.

Tomicus cacographus Leconte.

Injuring the pines of North Carolina and southward even more than *T. pini* in the north; a very similar beetle, with similar habits.

This is the *Bostrichus pini* of Zimmermann, but not the one so named by Say. It inhabits, according to Leconte, the Southern and Western States. It is said by Leconte to be similar to *Tomicus calligraphus*, but is usually of smaller size (3.5–4^{mm}, .14–.16 inch); the cusp of the second interspace is very small, and that of the third is wanting; that of the fifth is compressed and scarcely more prominent than that of the fourth interspace, and is somewhat connected with it; there are but two teeth between the tooth of the fifth interspace and the terminal acutely elevated margin, and these teeth are all of them less prominent than in *T. calligraphus* in some specimens (♂), but equally prominent in others (♀), those less acute than in *T. calligraphus*. The interspaces from the third outward are marked each with a regular series of punctures behind the middle, whereby it differs from the next species (*T. confusus* Leconte, of Southern California and Arizona). The club of the antennæ is quite similar to that of *T. calligraphus*.*

The mine made by this species has been found under the bark of the southern pine at Atlanta, Ga., the beetle from it having been labeled by Dr. Horn. The mine is like that of *T. calligraphus*, but the main burrow is narrower, being 2½^{mm} wide, and the holes are smaller, the beetle itself being smaller. Living beetles were taken from the mine March 28, 1881.

32. PINE BARK-BEETLE.

Tomicus pini Say.

From a common center excavating several broad shortish galleries lengthwise of the trunk in opposite directions, resembling the spread fingers of a hand; a bark-beetle very similar to the preceding, but of smaller size, measuring only 0.15 in length, and with but four small teeth on each side of the concave declivity at the tips of its wing-covers, and usually showing more or less distinctly an impressed line along the middle of the hind part of its thorax. (Fitch.)

The tracks formed by this insect are so different from those of the other species that they are recognized at a glance. They occur under

* A number of other Scolytids which probably infest the pine are described by Leconte in his work on the Rhynchophora of America north of Mexico, where all the species are characterized, and to which the reader is referred.

the bark of old trees of the white pine, and have some resemblance to the fingers of a hand spread apart, or to the track of a bird. From a common center they run off in opposite directions up and down the tree, lengthwise of the grain, moderately diverging or nearly parallel with each other, appearing, when the bark is stripped off, like linear grooves in the outer surface of the wood and inner surface of the bark. They are about 0.10 wide and 1.50 to 2.00 long, all those belonging to the same cluster being of nearly equal length. Along the sides of these grooves several short sinuous excavations or notches appear, in which the eggs have been placed, where they would remain undisturbed by the beetle as it crawled backwards and forth through the gallery. The accompanying figure* is a representation of one of the clusters of these tracks, copied from the surface of the wood. In this instance, the commencement of some of the galleries, and the principal part of the lower one on the right hand, had been excavated wholly in the bark, and thus made no mark upon the wood.

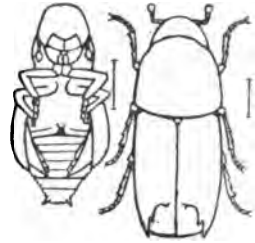


FIG. 76.—Pine bark-borer and pupa.—From Packard.

M. Perrish has ascertained that with the European *Tomicus laricis*, which excavates several galleries from a common center like the insect now before us, a male beetle is found in each of the galleries, whilst only one female is associated with them, she being stationed sometimes alone, in the center, and at other times in one of the galleries in company with the male. And from his observations it appears that these galleries are excavated by the males, each of them being the work of one individual, whilst the female supplies the whole of them with eggs.

As there are no lateral galleries branching off from these main ones, I infer that the young of this insect move and feed along the sides of the galleries in which they are born, and that thus these galleries become widened and broad as we find them, their width being much greater than those of the other species, although the insect is but the usual size. (Fitch.)

We have little to add to the foregoing account as to the habits of this bark-borer. It is common in the pine woods of Maine, making burrows under the bark, not always so regular as Fitch figures.

This timber-beetle is common in the timber region of the Rocky Mountains of Colorado, boring irregularly into the inner bark of *Abies menziesii*. The burrows are like those made by the same insect in the white pines from Maine to North Carolina. On the Atlantic coast the more regular burrows radiate from a common center. Those observed on Gray's Peak were 0.08 inch in diameter.

In the pupa the body ends in two long, pointed, horn-like appendages arising from each side beneath. The ends of the hind tarsi extend to the terminal third of the wings. The antennæ are clavate, not extend-

* Not here reproduced.

ing beyond the coxæ of the first legs. It is larger, more bulky than the adult. Length, 0.22 inch.

The beetle (Fig. 76) is cylindrical, with the head and prothorax together three-fourths as long as the rest of the body; end of the abdomen suddenly truncated, slanting, forming a scoop, the declivity smooth, concave, and bounded by high walls, which are four-toothed on each side, the third from the top the largest. On each wing-cover are eight lines of fine, raised tubercles; prothorax with concentric rows of fine tubercles, but smooth on the posterior third. Seen from beneath, the wing-covers project well beyond the end of the abdomen. Color, pale tan-brown, a little paler on the thorax than on the wing-covers. Body covered with stiff, dense hairs. Length, 0.20 inch.

34. THE LITTLE BARK-BEETLE.

Pityophthorus puberulus Leconte.*

Under the bark of small sapling pines, mining exceedingly fine slender wavy burrows running in every direction; a cylindrical chestnut-brown bark-beetle much smaller than any of our other species, measuring only 0.06 in length, its surface shining and pierced with small deep punctures which on the wing-covers are placed in close rows, the thorax but half as long as the wing-covers and rough anteriorly from dense minute elevated points, the middle of the outer edge of the wing-covers showing a slight concavity, the declivity at their tips with a moderate excavation formed by a smooth longitudinal groove upon each side of the suture, the suture itself being elevated and having on each side of it an impressed line in which are minute punctures, the outer margin of the declivity with numerous fine bristles, but without any projecting teeth, and the tips of the wing-covers drawn out into a very small acute point.

This beetle very closely resembles the *T. ramulorum* of Perris, which mines the small twigs of European pines, but it is evidently a distinct species. It was described by Dr. Harris in the Transactions of the Natural History Society of Hartford, Conn., vol. i, p. 82, from a specimen imperfectly displayed, which he met with in the collection of Mr. Halsey, but he had no knowledge of its habits. And this I believe is the only notice of this insect which has hitherto appeared. Its minute size has probably caused it to be overlooked by collectors, although it is so common that the bark of dead young pines which are two inches in diameter or less can seldom be broken away without coming upon its tracks, with some of the dead insects in them. Its tracks are readily distinguished from those of other species by their extreme slenderness, and being packed with fine white sawdust they resemble a tangled mass of small threads lying upon the surface of the wood. On coming to inspect them particularly, small irregular cavities will be noticed, one of which is represented by a knot-like appearance. This cavity is appropriately termed the nuptial chamber by French and German writers. From it

* Leconte states that this is not the *Tomicus pusillus* of Harris, as Fitch supposed, "but is quite different, and is closely allied to *T. ramulorum* Perris, which is considered by Eichhoff as the same with *typographus* Ratzburg." Leconte adds in a letter that this is most probably *P. puberulus*

there are usually four galleries leading off in opposite directions and running obliquely to the grain of the wood, but curving, commonly, till they obtain a longitudinal direction. And from these numerous smaller and irregular wavy galleries branch off, at right angles or nearly so, and overspread the whole surface with a seemingly confused multitude of little furrows. The bark being quite thin in the young trees to which these beetles resort, their galleries are excavated mostly in the wood, the surface of which is deeply grooved whilst only a shallow impression is made on the inner surface of the bark. But at the end of each of the lateral galleries, a deep cavity will be noticed, sunk in the bark, in which cavities the insects repose during their pupa state.

The accompanying figure of the tracks of these beetles handsomely illustrates some of the facts which have already been stated above under the Wood-engraver bark-beetle, and it may interest the reader to notice some of the habits of these insects as shown by this figure.* In its upper half two leading galleries are seen running parallel with each other and so near together that no adequate space exists between them for any young larvæ to form their burrows there without encroaching upon each other or crossing the tracks already made. The parent beetles appear to have been aware of this, and accordingly so disposed of their eggs that all their young with but two or three exceptions mined outwards, traveling away from each other. Again, on the outer side of the left gallery two notches are observed, in which no eggs appear to have been placed, the parent beetle probably perceiving, what the figure indicates, that there was not suitable room to the left of these notches to duly accommodate all of the other larvæ that would traverse that spot. Furthermore, it will be noticed that of the burrows leading off to the right, above the large knot or nuptial chamber, the worm which excavated the fourth one, soon after commencing his journey perceived that the course he was pursuing would run his track into that of the third one. He hereupon abruptly alters his course, bearing directly away from the track of this neighbor until he has attained a suitable distance therefrom, and he then travels forward again, keeping at this exact distance from his neighbor's path. But this soon brings him into proximity with another neighbor upon the other side; and he now becomes aware of the fact that he is between two paths that are approaching each other, and that will consequently come so near together forward of him that he cannot proceed onward without running into one or the other of them. In this dilemma, to encroach the least that is possible upon his neighbors, he makes an abrupt turn so as to go square across one of these tracks. But this only serves to bring him into similar proximity with another track, and after this comes another and another; and now he reaches a fifth one, running in a different direction, requiring another alteration of his course to cross it at right angles. But we need not follow this subject further. Others also of these galleries,

* Not reproduced.

when carefully inspected, will be found scarcely less curious. How wonderful is nature, that thus presents an interesting subject for our study in each particular track an inch or two in length which a family of little worms make as they eat their way along in the bark of a tree, the parenchyma of a leaf, or elsewhere! How marvelous, that in such minute and seemingly unimportant and insignificant operations, we invariably meet with so much to admire! (Fitch.)

35. THE LEAST WHITE-PINE BARK-BORER.

Pityophthorus puberulus Leconte.

Very abundant under the bark of the white pine, a very small timber-beetle with long narrow secondary galleries branching off from the main one.

This may possibly be the insect which Dr. Fitch has regarded as the *Tomicus pusillus* of Harris. We have found the mines in abundance

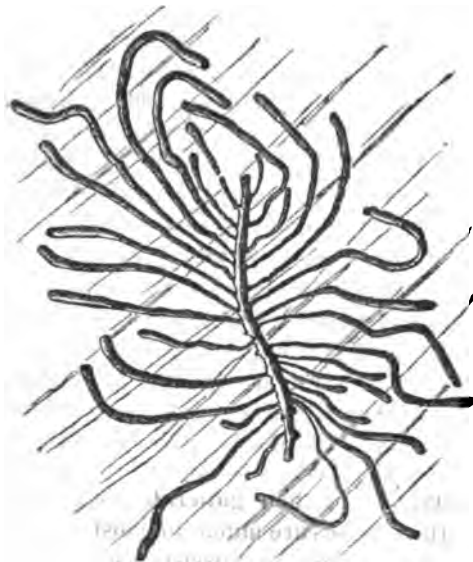


FIG. 77.—Mine of least white-pine bark-borer, Providence, R. I.—Packard del.

under the bark of the white pine at Providence, R. I., sometimes four or five occurring in the space of six or seven square inches. They vary a good deal in irregularity, and we will select the one here figured for description as being one of the more regular mines. The main gallery is slightly sinuous, from $1\frac{1}{2}$ to 2 inches long, originally notched alternately on the sides, the notches where the eggs are laid being the starting point for the secondary galleries where the larvæ have hatched and lived. About fifteen secondary galleries arise from each side of the primary mine, the longest being about two-thirds as long as the primary gallery; all end in a slight enlargement in which the larva transforms, or connect with the hole through the bark for the exit of the insect. (The figure, as engraved, makes the main gallery and branches somewhat wider than in nature, and wider than in my original drawing.) The width of the main gallery is $1\frac{1}{2}$ mm; of the secondary gallery, 1 mm. In some cases two main galleries cross each other, while in another case two unite to make a figure 8, but in such a case the secondary galleries do not cross the main ones, and in examples where two main galleries run parallel and somewhat near each other, they do not send secondary galleries into the narrow interspaces between the two main galleries.

On submitting specimens of the beetle to Dr. Leconte for identifica-

tion, he writes us that it is a species of *Pityophthorus*, not described. Dr. Leconte adds: "Blanchard writes that *Hypophlæus tenuis* depredates on this species." (Leconte afterwards identifies it as probably *P. puberulus*.)

36. *Xyleborus impressus* Eichhoff.

Leconte states that this species occurs in Georgia under pine bark.

37. PINE TIMBER-BEETLE.

Pityophthorus materiarius Fitch.

Order COLEOPTERA; family SCOLYTIDÆ.

In the interior of the sap wood, mining slender straight cylindrical burrows in a transverse direction, parallel with the outer surface, from which very short straight lateral galleries branch off at right angles above and below; a rather slender cylindrical black shining bark-beetle, 0.15 long, with pale dull yellow legs and antennæ, the fore part of its thorax and of its wing-covers tinged with reddish yellow; the thorax equaling two-thirds the length of the wing-covers with a small elevated tubercle in the middle, forward of which it is rough from minute elevated points; the wing-covers with rows of minute punctures, their tips rounded, the upper part of the declivity with a shallow longitudinal depression or groove along the suture, forming a slight notch.

The insects belonging to the genus *Tomicus* and kindred genera of the same family by their habits divide themselves into two distinct groups. The larger portion of them reside in or immediately beneath the bark of different trees, and are currently termed bark-beetles. But this designation is inappropriate for another portion of them which dwell in the interior of the wood, and there excavate their galleries. The name timber-beetles appears to be the most appropriate for these. Another point in which, from the observations of M. Perris, these two groups appear to differ in a remarkable manner, is the relative numbers of the two sexes. With the bark-beetles there are commonly several males in company with but one female, and the former appear to perform the chief part of the labor in the excavation of their galleries. With the timber-beetles, on the other hand, the females are much the most numerous, and probably mine their galleries without any assistance from the other sex. M. Perris states of one of the species that upwards of fifty females were met with in the burrows they had excavated without a single male being found there.

It is the habit of these timber-beetles to penetrate the tree in a straight line, passing inwards through the bark and into the sap wood to a depth of from half an inch to two inches, and then abruptly turning they extend their burrow in another straight line parallel with the outer surface and at right angles with the fibers of the wood, for a length of two to six inches. The only instance in which the burrow of the species now under consideration has come under my notice was recently in a billet of stove wood, which unfortunately did not contain the extreme end of the gallery. The annexed cut* is an exact representation of this bur-

* Not reproduced.

row, in which a live and a dead beetle were found, both of them females, and the only specimens of this species which have come under my observation. The transverse burrow was excavated in the sap wood at the depth of half an inch from its outer surface. Near its middle it was crossed by another perforation extending from the outside directly towards the heart of the tree, which is indicated by a black dot in the figure; and at this point the burrow curved slightly outwards towards the exterior surface, as represented in the section above the principal figure in the cut; and at its end on the left, where it passed out of the billet of wood, it commenced curving inwards towards the heart of the tree. Twelve lateral burrows of the same diameter as the transverse one extended upwards and two downwards, as shown in the figure, all of the same length, each one having been excavated probably by a single larvæ. The gallery of our insect thus differs widely from that of the European species (*T. eurygaster* Erichson) which mines in the interior of the pine, which has no lateral burrows branching off from it.

The presence of these timber-beetles in the wood can be distinguished from those which mine under the bark by the little piles of sawdust which they throw out at the mouth of their burrows, this dust being so much more white and clean, and not composed in part of the brown or rust-colored particles of gnawed bark which are intermixed with the dust produced by the bark-beetles. (Fitch.)

The beetle.—In addition to the short description of this beetle which is given above, it may be observed that the head is finely punctured, the punctures on the face giving out small pale yellowish hairs, while those on the vertex or crown are destitute of hairs, and there is a slight transverse elevation of the surface between the face and the vertex, from which an elevated smooth line extends backwards along the middle of the vertex. Thorax, when viewed from above, with its base transverse and rectilinear, its basal angles rectangular, its opposite sides parallel for a distance equaling the length of the base, and from thence rounded in a semicircle at its anterior end; its surface anteriorly with minute asperities, which, viewed vertically, appear like fine transverse wrinkles; its basal half with very minute punctures, and in its center a small transverse tubercle. Wing-covers with fine shallow punctures in rows; the upper part of the apical declivity moderately depressed in the middle, producing a slight concavity in its outline when viewed from above anteriorly, the suture not elevated in this depression, but showing a slightly impressed line along each side; the hind end bearded with hairs similar to those upon the front. Under side black, the legs and antennæ pale dull yellow. (Fitch.)

We have found this beetle in the pine woods of Maine; it was kindly identified for us by Dr. Leconte. It bores deep into the sapwood of *Pinus strobus* in long nearly straight burrows; the beetles may be found in them in March, their heads pointing towards the center of the tree.

This species, or one very similar to it, has been found by Mr. Hunting-

ton, of Kelly's Island, Ohio, to bore into empty wine casks and spoil them for use. (Guide to Study of Insects, p. 493.)

38. THE SPRUCE TIMBER BEETLE.

Xyloterus bivittatus Mannheim.

This insect, though common under the bark of the white pine in Maine, is especially destructive to the spruce and fir, and for a further account the reader is referred to spruce insects.

39. THE PINE-BARK CARVER.

Xyleborus cælatus Zimmermann.

Occurring in all stages of growth in July and August under white pine and spruce bark in Maine, sometimes in immense numbers, sufficient to kill the tree, a rather stout bark-borer, the declivity of the elytra with two prominent tubercles and some smaller marginal ones, with rows of punctures.

Bark borers of this genus are said by Leconte to have the body stout, cylindrical, with the slope of the elytra oblique, scarcely flattened; the funicle of the antennæ with four distinct joints, and the sensitive surface of the antennæ concentrically annulated. In the present species along the slope of the elytra are two prominent tubercles and some smaller marginal ones, the elytra are strongly punctured in rows, the interspaces with rows of distant punctures, while the tibiæ are strongly serrate.

From eight hundred to a thousand specimens of this bark borer, with hundreds of larvæ and many pupæ, were found in July and August at Brunswick, Maine, under the bark of a white pine stump about 22 inches in diameter, the tree having been cut down the preceding November. The bark was honey-combed with its holes, the pupæ resting in cells in the bark. The mines usually run obliquely through the thick bark, not sinking into the sapwood, so that no regular mine was formed, and it is difficult to give a good description of it. The diameter of the track and of the hole for the exit of the beetle is slightly larger than that of *Xyloterus bivittatus*. It is often two-striped, but this is due to the fact that it begins to turn dark after transforming in the middle of the elytra. It also occurred in abundance under the bark of the spruce, in the same place, associated with *X. bivittatus*, and also with the common undescribed species of *Dolurgus* to be noticed under spruce insects.

40. *Dryocates septentrionis* (Mann).

Occurring under the bark of the pine in Alaska, Canada, and Virginia, a bark-borer closely allied to *Xyleborus*, with the prothorax strongly punctured, not roughened in front; length 4.4^{mm} (0.17 inch).—Leconte.

41. THE BORING HYLURGUS.

Hylurgus terebrans (Olivier).

Order COLEOPTERA; family SCOLYTIDÆ.

Perforating larger holes in the bark than any of the preceding bark-beetles, and mining curved galleries in every direction in the inner layers of the bark, and slightly grooving the outer surface of the wood; a cylindrical light chestnut-red or yellowish

fox-colored beetle 0.23 to 0.33 long, bluntly rounded at each end, thinly clothed with yellowish hairs, its thorax narrowed anteriorly and with coarsish shallow punctures, and a slightly raised line along the middle, at least on the posterior half, a faint blackish line along the middle of the upper part of the head, and its wing-covers rough, with rather shallow furrows, in which are coarse indistinct punctures. Appearing abroad early in May, numerous in pine forests and in lumber and mill yards. Its larvæ common under the thick bark of pine logs and stumps; a yellowish white footless grub thinly clothed with yellowish hairs, and divided into thirteen segments, its head polished and horny, of a tawny yellow color, with the mouth black, and the neck having on each side, above, a large polished spot tinged with tawny yellow. (Harris's Treatise, page 75.)

With this account taken from Harris, our own observations agree. The cells are smaller than those of *Pissodes strobi*. We have found the larvæ and immature beetles in abundance in Brunswick, Maine, in the middle of March. The burrows are very irregular, winding about under the bark, while the very irregular cells are from half an inch to an inch long, and nearly a quarter of an inch wide, and surrounded with the white woody chips made by the larva before pupating.

Leconte states that in this species the prothorax is very densely and coarsely punctured; the hairs of the elytra not being very long. It has been collected in Canada, Georgia, Oregon, and California, as well as the pine woods of New England and Northern New York. "The specimens from the Pacific slope are larger, and the punctures of the prothorax are rather smaller and more dense, but these differences do not seem to me worthy of specific distinction. Some specimens from New Hampshire and Canada have the prothorax more sparsely punctured, almost as in the next species (*D. similis*), from which they are only distinguished by the shorter hairs of the elytra. Length 5.2^{mm} to 8^{mm} (.2 to 3.2 inch).

42. THE STOUT PINE-BORER.

Dendroctonus rufipennis Kirby.

Boring irregular galleries under the bark of the pitch pine, somewhat like those of *Tomicus pini*, but much less regular and twice as wide and deep, a reddish brown bark-borer.

This beetle, abundant in the New England States, is not uncommon in Colorado. I met with it at Blackhawk and at Manitou. It probably bores in the pines and spruces of the Rocky Mountains. It is short and stout, reddish brown, the head and prothorax smooth and shining, though finely punctured, while the wing-covers are coarsely punctured and dull-colored, being a little darker than the rest of the body. Length 0.35 inch.

FIG. 78.—*Dendroctonus rufipennis*.—From Packard.

Leconte states that he has received specimens from Alaska, Canada, and Anticosti. It is a common northern species. It is only to be distinguished from *D. similis*, says Leconte, by the declivity of the elytra being smoother and more shining, and almost without asperities; and by a slight difference in the punctures of the prothorax, which are of

unequal size. The dorsal line of the prothorax is sometimes narrow and elevated, sometimes obsolete. Length 6^{mm} (.24 inch). The distinctive characters given by Leconte are these: prothorax punctured, with smaller punctures intermixed; hairs of elytra long. We have found it at Providence, R. I., in its burrows under the bark of the white pine.

Allied to these two species of *Dendroctonus*, and undoubtedly infesting coniferous trees, are the following:

Dendroctonus similis Leconte, Colorado. "A smaller and somewhat more elongate form occurs in Canada, Texas, and Colorado, but I do not think it capable of being separated as a distinct species."

Dendroctonus punctatus Lec. New York.

Dendroctonus simplex Lec. Canada.

Dendroctonus brevicornis Lec. Middle California.

Dendroctonus frontalis Zimmerman. Lake Superior to Georgia.

43. THE PINE HYLASTES.

Hylurgops pinifex Fitch.

.Order COLEOPTERA; family SCOLYTIDÆ.

A beetle which closely resembles the preceding, and is frequently met with in company with it upon pine lumber in mill yards early in May, requires to be noticed in this place. I am unable to find any description of this species, although it is so common it can scarcely have been overlooked by authors till this time. It is the *Hylastes pinifex*, or the pine-destroying Hylastes of my cabinet. Its habits are doubtless very similar to those of the boring Hylurgus, but the beetle is always slightly smaller measuring 0.20 in length, and is darker colored, being deep chestnut red or sometimes black, tinged with chestnut. It moreover is destitute of the hairiness of that species, having only a thin fine short beard on the hind part of its wing-covers. Its thorax and wing-covers have the same sculpture with that. Its head shows no line along the middle, except upon the upper lip, where is a slender short elevated one, which ends before it reaches a slight transverse depression which crosses the lower part of the face. Its body beneath is black, the legs dark chestnut, with the thighs commonly black. It moreover differs generically from the preceding in having seven, instead of but four, small joints in its antennæ, between the long club-shaped basal joint and the knob at the tip, which knob is shaped like an egg, and is divided by transverse lines into four short joints. Its shanks also have only fine denticulations along their outer edge near the tip, in place of the coarse saw-like teeth, which are seen in the foregoing insect. It thus pertains to the genus *Hylastes* of Erichson. (Fitch.)

I have found several beetles of this species (identified by Dr. Horn) under the bark of a white pine stump, at Brunswick, Me., August 15-20, 1881. The tree was felled in November, 1880. The beetles had evidently recently transformed from the pupa state, as they were with one exception pale red, the color of the fully mature beetle being black-brown.

44. THE COAL-BLACK HYLASTES.

Hylastes porculus Er. (*carbonarius* Fitch).

A beetle so closely like the preceding that it merits to be noticed in connection therewith is the *Hylastes carbonarius* of my cabinet. It is 0.20 long, of a pure black color, except its feet and antennæ, which are chestnut red. Its face shows no transverse depression inferiorly, but has an elevated line along the middle, reaching a third

of its length. The smooth line along the middle of the thorax is less distinct than in the foregoing species, being slightly if at all elevated, and the punctures of this part are more coarse. Its wing-covers are not bearded posteriorly, and its general form is plainly more narrow and slender than that of the Pine Hylastes. The only specimen I have seen was captured the middle of July in the yard in front of my dwelling. (Fitch.)

45. THE PALES WEEVIL.

Hylobius pales Herbst.

Order COLEOPTERA; family CURCULIONIDÆ.

A large dark-chestnut colored or black weevil, 0.30 to 0.40 long, sprinkled over more or less with dots, whereof one on the middle of the outer side of the wing-covers is more bright, these dots being formed by fine short yellowish gray-hairs. Quite common in May and June among pine trees, and in mill yards, and on piles of pine lumber; with its long cylindrical snout perforating the bark and crowding an egg into the hole, the larva from which, similar in its appearance to that of the white-pine weevil, burrows beneath the bark, loosening it from the wood. (Harris's Treatise, p. 61.)

This is a very common pine insect, which ranges from Maine and Lake Superior to Florida. Leconte states that the head is very densely, though not coarsely, punctured, and is nearly opaque; the prothorax is coarsely and rugosely punctured. The pubescence of the clypeal spots is sometimes yellow, sometimes gray. Length 6.8^{mm} to 10.2^{mm}; .27-.4 inch. There are several closely-allied species which probably will be found to depredate on the pine.

Our own observations on this borer were made many years ago at Brunswick, Maine. The burrows run under the bark of the trunk of the white pine; they extend irregularly over the inner surface of the bark, sinking down into the sap wood, where in the autumn the larva makes a cell nearly a quarter of an inch deep, arched over at the top with a thick roof of "sawdust" or chips it had bitten off from the wood; over a surface of four square inches were eight or ten cells. Each cell in the middle of March contains a yellowish-white footless grub, half an inch long. Two weeks later we found two pupæ and two perfect beetles, one apparently having just thrown off its pupa skin.

The history of the *pales* weevil seems, then, to be somewhat as follows: In May and June the beetle bores its way out from the cell, partially creeping out of the old larval burrow; flies about on sunny, warm days in April and May, then lays its eggs either on the sides of the opening of its old burrow, or in the crevices of the bark. Early in summer the young worm hatches, and burrows under the bark throughout the summer, until it matures in the autumn, and makes the cell deep in the sap wood, where it hibernates, and about the first of April changes to a pupa.

The cycle of its life is completed when the beetles fly forth early in May, and seek their mates, preparatory to laying the eggs from which a third generation are born. We have found the weevils flying about in Providence, R. I., during the middle of May.

46. THE TWO-FORKED SOUTHERN TIMBER-BEETLE.

Carphoborus bifurcus Eichhoff.

Inhabiting the southern pine; mine consisting of a long, sinuous, narrow, primary gallery, from which rather short secondary galleries run out at nearly right angles; the beetle being minute.

Leconte states the species of this genus are next allied to *Dendroctonus*, but are minute in size and with long bodies. The elytra are striate with large approximate punctures. The funicle of the antennæ is 5-jointed; first joint large and rounded, the others closely united, forming a short, conical mass, as in *Phlæosinus*; club large, slightly pubescent, moderately compressed; rounded, obtuse at tip, and divided by two straight sutures; the first joint of the club is more shining than the others. There are three species of the genus, *C. simplex* inhabiting the Mohave Desert, California. *C. bifurcus* differs from *C. bicristatus* in having the first and third interspaces of the elytra all moderately elevated, the second not much narrowed on the declivity or inclined end of the elytra. The punctures of the elytral striæ are also larger. Leconte seems to suggest that the two eastern species may eventually be united. Length, 1.5^{mm} (.06 inch).

The mine of this beetle I found under the bark of the southern pine at Montgomery, Ala.; the beetles taken therefrom having been submitted to Dr. Horn for identification. The figure well represents an average mine. The primary gallery is nearly four inches long, very narrow, somewhat sinuous, ending at one end in a broad cell from which three or four secondary galleries pass off. About twenty secondary galleries pass off on each side at right angles to the main gallery, but not all in the same plane, as the figure shows; they are rather short, less than an inch in length, and sometimes end in a broad, irregular cell; the round dark spots in the figure indicate the holes in the bark for the exit of the insect. It appears to be a common pest in the Gulf States.



FIG. 79.—Mine of *Carphoborus bifurcus*; natural size.—Packard, del.

47. THE TWO-CRESTED SOUTHERN TIMBER BEETLE.

Carphoborus bicristatus Chapins.

In Georgia occurring under pine bark, according to Leconte. Length, 1.8^{mm} (.07 inch).

The five following Scolytids also occur on the pine. The notes are

taken from Leconte's essay on the Rhynchophora, or weevils of the United States.

48. *Hypomolyx pinicola* Leconte.

This species was originally described by Couper (Trans Lit. and Historical Society of Quebec, 1864), under the name of *Hylobius pinicola*. The body is elongate, ovate, broader behind, the eyes small, elytra oval, convex; the beak is as long as the prothorax, rather stout, slightly curved; the prothorax is rather small, subserrate on the sides, very coarsely punctured, thinly clothed with coarse hair, carinate in front; the elytra are densely punctured, mottled with small spots of yellow hair; striæ composed of large elongate deep punctures. Length, 13.5^{mm} (.5-.3 inch).

49. *Hilipus squamosus* Leconte.

The genus *Hilipus*, says Leconte, largely developed in tropical America, is represented by a single rare species found in Georgia and Florida, where it occurs under pine bark. It differs from *Hylobius* in the body being ornamented with small scales instead of spots of fine pubescence. It is a beautiful black insect, with a broad white lateral vitta on the prothorax, and a very irregular one on the elytra, with many scattered small spots, densely clothed with depressed, very small, round, chalky white scales. Punctures of elytra very large, distant; interspaces smooth, shining, except where covered with scales. Length, 14.4^{mm} (.57 inch).

50. *Crypturgus atomus* Leconte.

Canada, Massachusetts, New York; under bark of dead pine branches. Length, 1^{mm} (.04 inch).

This species, though common in white pine bark, is especially destructive to the spruce, and is more fully described under the head of spruce insects. It occurred in abundance at Brunswick, Me., in all stages of development, from the fully-grown larvæ to the beetle under the bark of white pine stumps (the trees having been felled the previous November), from the middle of July until the 1st of September, and probably still later.

51. *Ernobius tenuicornis* Leconte.

Order COLEOPTERA; family PTINIDÆ.

According to Leconte this beetle has been detected in the boughs of *Pinus rigida* in Massachusetts by Mr. Blanchard. (Trans. Amer. Ent. Soc., viii, xxiii, 1880.)

52. THE PINE ÆGERIAN.

Ægeria pini Kellicott.

Order LEPIDOPTERA; family ÆGERIADÆ.

Boring in autumn under the bark and into the superficial layers of wood, usually just below a branch, a white smooth caterpillar an inch long, transforming to chrysalids late in May, the moth appearing from the middle to the end of June. (Kellicott.)

Mr. Kellicott gives the following account of this insect :

"When studying the larval habits of *Pinipestis zimmermani* in 1878-'79, I met with the larvæ and pupa skins of two moths evidently different from the pine pest, yet having quite similar larval habits. During the past summer I succeeded in getting the moth of one of them; it is an *Ægerian*, as I think, undescribed, but I would not venture upon describing it had I only the imago; but as I am able to give mainly its history, and having done so much tramping and climbing for its sake, that I have come to feel a proprietary right, I undertake to name and describe it as new. As its proposed name implies, the larva inhabits the pine, boring under the bark and into the superficial layers of the wood. From the wounds thus made pitch exudes, which, through the action of the larva and the warmth of the sun, forms hemispherical masses over its burrows; in these masses the pupa cells are finally prepared and the inactive stage passed. The larva occurs more frequently than elsewhere just below a branch; sometimes about the border of a wound made by the axe, or where a limb has been wrenched off by the wind; rarely in the axil of the branch. It appears to attack larger trees than the Zimmerman's pine pest, and more frequently occurs at considerable altitude. I have taken them thirty to forty feet from the ground. While they sometimes, perhaps as a rule, take advantage of the broken cortex, I have found them where it appeared that they had worked through the same into the soft layer.

"I have found the larva in the following localities: Hastings Center, N. Y.; Portage, N. Y., Buffalo, N. Y. (?); Point Abino, Ontario. At the first-named place, they were found in several instances numerous enough to seriously injure trees of moderate growth. I have taken the larvæ in autumn from 0.25 to 0.75 of an inch in length; they finally attain a length of 1 to 1.1 inch; diameter quite uniform, 0.18 of an inch. Color white; head light brown, flattened; first thoracic ring slightly clouded with brown, smooth; no trace of an anal shield; true legs scarcely colored, pro-legs prominent, crowned with two rows of about eight hooks each. The brown hairs arise from papillæ, the base of each hair being surrounded by a brown annulation. The spiracles are but slightly elliptical, last pair large, placed sub-dorsally.

"Before transforming they prepare a cell in the extruded pitch mingled with their *débris*; this they line with silk, but spin no other cocoon. While in their burrows they move through the soft pitch with impunity, but if removed from the same they soon die from the encumbrance of the hardening pitch adhering to them.

I have found the pupa the last of May; the moth appears from the middle to the end of June. It may be that others come in July and August, for I have found larvæ apparently full grown in July. On the 15th of July I brought to my rooms, devoted to the rearing of insects, some blocks of wood containing such apparently mature larvæ, expecting them to complete their transformations in a few weeks at most;

they are still in their pitch cells unchanged (Nov.). Is it a case of retarded development, due to the drying of the bark and wood?

The pupa has a length of 0.73 of an inch. Color light brown with the extremities dark. Over the dorsal portion of the abdominal rings are the usual rows of teeth; those on the anterior margins scarcely extend below the spiracles. The clypeus is without a pointed process; the medio-dorsal ridge of the thorax is unusually prominent.

When about to transform it bores through the pitch wall and escapes, leaving the pupa skin protruding.

The moth (female) expands 1.2 inch. Fore wings opaque; hind wings transparent. Color blue-black, as follows: fore wings, the clothed portions of hind wings, head, palpi, thorax, upper part of abdomen, antennæ, and legs. The neck fringe and the sides of the collar are orange, also the ventral side of the abdomen and the tail fringes. The antennæ are long, slightly enlarged toward the end; there is a decided orange line on the under side of the antennæ for one-third their length; the tarsi are smoky. The male not seen. (Canadian Entomologist, xiii, p. 5-7, 1881.)

53. THE PITCH-DROP MOTH.

Nephopteryx (Pinipestis) Zimmermanni Grote.

Order LEPIDOPTERA; family PYRALIDÆ.

In June and July wounding the trunk of the red and white pine below the insertion of the branches, the presence of the larva being detected by the exuding pitch; the larva livid or blackish green, eating on the inner side of the bark and making furrows in the wood; in July spinning a papery cocoon, the moth appearing from 10 to 14 days afterwards.

Mr. A. R. Grote has called attention in the *Canadian Entomologist* (vol. ix, p. 161) to this pest of the red pine (*Pinus resinosa*) and white pine (*Pinus strobus*). The caterpillar occurs in the months of June and July, when the trees affected show by the exuding pitch that they are suffering from the attacks of this insect. The wound occurs on the main stem below the insertion of the branch. The worm in July spins a whitish, thin, papery cocoon in the mass of exuding pitch, which seems to act as a protection to both the larva and the chrysalis. The moth appears in ten to fourteen days after the cocoon is spun.

Mr. Grote adds that the worm usually infests the main stem at the insertion of the branches; and from the fact that the pitch of the trees protects the caterpillars no wash would injure the insect; hence extermination with the knife is the only remedy.

In vol. x of the same journal (p. 20) Mr. C. D. Zimmerman, the original discoverer of this pest, gives some further account of it. He writes that there is scarcely a pine more than four feet high on his grounds which is not more or less affected by this borer. "I have found it on *Pinus strobus*, *P. rubra* or *resinosa*, *P. austriaca*, *P. sylvestris*, *P. cembra*, Corsican, lofty Bothan and Russian pines. *P. sylvestris* seems to suffer most, as the limbs, and often the main stems, are constantly breaking off. Only a few days ago one of our finest specimens of *P. strobus* (a

tree over 30 feet in height and almost perfect in shape) had about 6 feet of the top broken off—the effects of this borer. I am in hopes the small parasitic flies I found in the larva will soon get the upper hand, so as to keep them in check.”

Additional observations have also been made by Mr. D. S. Kellicott, who states* that the moth is pretty widely spread, as it occurs not only in foreign and native pines in and about Buffalo, but that he has “found it quite abundant in small white pines of the forest at Cheektowaga, Erie County, New York. At this place I found many plants had been dwarfed and ruined by their ravages. It also occurs, to what extent I am unable to say, at Hamburg and Clarence Center, in the same county. I recently visited a portion of this State, Oswego County, formerly clad to some considerable extent with white pine, and there are yet standing some virgin forests of this splendid tree: In divers places in that county I found our borer; it is so abundant, in one locality at least, that it proves a grave enemy to the young pines of second growth where the primitive trees have been removed by the lumbermen. There is near Hastings Center an old slash in which at least one-half of the many such small pines have been injured; indeed, in one neglected corner, among scores, scarcely one tree had escaped. In this instance, also, many pines were stunted, while some thus weakened had been broken off by the wind.” * * * “In a clump of pines, whose trunks were from 6 inches to 1 foot in diameter, many of the larger ones had been ‘boxed,’ i. e., inclined incisions had been cut by the axe through the sap wood in order to catch the pitch exuding from the wound. Around the borders of these ‘boxes’ the galleries with both pupa skins and living larvæ were plentiful. It appears that the larva cannot penetrate the outer bark of other than quite tender trees; nor could I find evidence of their attacking the branches of larger trees, although I had opportunity to examine such that had been felled during the winter just past. Since the larva so readily takes advantage of a wound, may it not stand related as a messmate to other borers?” * * * “I have found the moth’s galleries in both trunk and branch, both above and below the whorls (usually below), sometimes completely girdling the stem, thus killing the portion above; in one instance I found a gallery passing from one whorl to the one above.”

Larva.—When fully grown, 16^{mm} to 18^{mm} in length. The head is shining chestnut-brown: the mandibles black. The body is livid or blackish green, naked, with a series of black dots, each dot giving rise to a single, rather stout bristle. The prothoracic shield is blackish. The larva has three pairs of thoracic or true-jointed feet, and four pairs of abdominal or false feet, besides anal claspers.† (Grote.)

* Canadian Entomologist, xi, p. 114, 1879.

†Mr. Kellicott found that the larva hibernates, as April 12 he found the caterpillars of various sizes from 0.25 to 0.7 inch in length. “None of those taken were ‘livid or blackish green,’ but dull white; nor do the hairs arise from a ‘series of black dots,’ but from light-brown ones. I take it to be a case where a naked hibernating larva is lighter than during the warm summer. Otherwise the caterpillars were as described by Mr. Grote.”

Chrysalis.—Cylindrical, smooth, narrow, blackish-brown, about 16^{mm} in length. The head is pointed, there being a pronounced clypeal protuberance; the segments are unarmed; the anal plate is provided with a row of four spines, and two others, more slender, on either side of the mesial line, below the first. (Grote.)

Moth.—The wings expand 30^{mm}. Blackish-gray, shaded with reddish on the basal and terminal fields of the fore wings. There are patches or lines of raised scales on the basal field, and on the anterior and darker portion of the median space. The median lines are prominent, consisting of double black lines inclosing pale bands. The inner line at the basal third is perpendicular, **W**-shaped or dentate. The outer line at the apical fourth is once more strongly indented below the costa. The black component lines do not seem to be more distinct on one side than on the other of the pale included bands or spaces. The median field is blackish, becoming pale towards the outer line; it shows a pale, sometimes whitish cellular spot, surmounted with raised scales. The terminal edge of the wing is again pale or ruddy before the terminal black line. Wings blackish. The hind wings are pale yellowish white, shaded with fuscous on the costal region and more or less terminally before the blackish terminal black line; fringe dusky. Beneath, the fore wings are blackish, marked with pale on the costa; hind wings as on the upper surface. Body blackish-gray, with often a reddish cast on the thorax above and on the vertex. The eyes are naked, the labial palpi long, ascending, with a moderate terminal joint. Tongue rather long. The gray abdomen is ringed with dirty white; the legs are dotted with pale. The species differs from the European *abietella* by the raised scale tufts on the wings, and Zeller declares it to be distinct from any European species. (Grote.)

54. THE PITCH-EATING WEEVIL.

Pachylobius picivorus (Germar).

A black weevil very similar to *Hylobius pales*, but destitute of any spots or dots, and having the same habits. This occurs in the southern part of our State, and becomes common farther south, but I have never met with it to the north of Albany. (Fitch.)

Leconte separates as a distinct genus from *Hylobius*, *H. picivorus*, which differs greatly from the other allied species of *Hylobius* by the tibiae being much shorter and stouter, and expanding at the tip. It is abundant under pine bark, adds Leconte, in the Southern States, less frequent in the Middle States.

55. THE WHITE-HORNED UROCERUS.

Urocerus albicornis Fabricius.

Order HYMENOPTERA; family UROCIDÆ.

A large black four-winged fly an inch long, having some resemblance to a wasp, but with a stout cylindrical body having the head and abdomen closely joined to the thorax, the base of the shanks and of the feet white, and also the antennæ except at their ends, and a spot behind each eye and another on each side of the abdomen, the wings smoky transparent. The abdomen ends in a point shaped like the head of a spear, below which is a straight awl-like ovipositor, about 0.40 long, with which it bores into the tree to deposit its eggs, the worm from which forms winding burrows in the wood, and is of a thick cylindrical form, divided into thirteen nearly equal segments, including the head, which is small, polished and horny, the last segment being largest of all and ending in a conical horn-like point, and the under side with three pairs of very small legs anteriorly.

These insects vary considerably in their colors and marks, and the two sexes are very dissimilar. The male, according to Dr. Harris, is black, with a white spot behind each eye, and a flattened russet-colored abdomen. (Harris's Treatise, p. 427.)

56. THE YELLOW-BANDED UROCEÆUS.

Urocerus abdominalis Harris.

A four-winged fly similar to the foregoing, about 0.80 long, of a blue-black color, with from two to four of the middle segments of its abdomen bright orange yellow, and also a broad band on the antennæ and the four forward legs except at their bases, its wings hyaline, tinged at the tips with a smoky color. There is sometimes a yellow spot behind each eye, and the hind knees and some or all of the joints of the hind feet are usually yellow. My specimens are males, nor has any female answering to this been found, and I am forced to entertain suspicions it is the true male of the preceding species. These insects are not common. (Harris's Treatise, p. 428.)

57. THE PINE BLIGHT.

Coccus pinicorticis Fitch.

Order HEMIPTERA; family COCCIDÆ.

Externally, upon the smooth bark of young trees, patches of white flocculent down-like matter, covering exceedingly minute lice invisible to the naked eye. (Trans. N. Y. State Ag. Soc., 1854, p. 871. Compare also an article by Dr. H. Shimer in Trans. Amer. Ent. Soc., ii, pp. 383-385.)

AFFECTING THE TWIGGS.

58. THE WHITE-PINE WEEVIL.

Pissodes strobi Peck.

Order COLEOPTERA; family CURCULIONIDÆ.

In May, depositing numerous eggs in the bark of the topmost shoot of young trees, the larvæ from which mine in the wood and pith, causing the shoot to wither and die, hereby occasioning a crook or fork in the body of the tree at this point; an oblong oval and rather narrow weevil about a quarter of an inch long, of a dull dark chestnut-brown color, with two dots on the thorax; the scutellum and a short irregular band back of the middle of the wing-covers milk white, the wing-covers also variegated with a few patches of tawny yellow.

This is a common insect in New York, and specimens of it may be found around and upon pine trees at all times of the year, but it is in the month of May that they are abroad in the greatest numbers, and it is chiefly at that time that their eggs are deposited. Young thrifty-growing pines are its favorite resort, and among these it selects those that are most vigorous, and whose topmost shoot has made the greatest advance the preceding year. But I have seen it so numerous that not only the topmost shoots of every tree in the grove, but many of the lateral ones also were invaded and destroyed by it.

It is in consequence of its smooth straight growth to such a lofty height that the pine has been prized beyond any other timber for large buildings and bridges, and is especially valuable for the masts of ships.

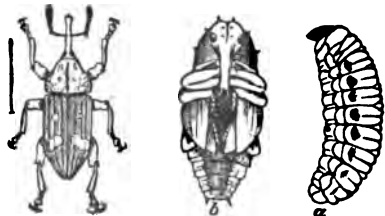


FIG. 80.—White-pine weevil; a, larva; b, pupa, enlarged nearly threetimes.—From Packard.

So very highly were the American pines esteemed for this last purpose, at an early day, that they were ranked with the precious metals, and a large portion of the lands of the State of New York were originally granted by the British crown, with an explicit reservation of "All mines of Gold and Silver, and also all White and other sorts of Pine trees fit for Masts, of the growth of twenty-four inches diameter and upwards at twelve inches from the earth, for Masts for the Royal Navy of us, our heirs and successors," under the stringent condition that "If they, our said grantees or any of them, their or any of their heirs or assigns, or any other person or persons by their, or any of their privity, consent or procurement shall fell, cut down or otherwise destroy any of the Pine trees by these presents reserved to us, our heirs and successors, or hereby intended so to be, without the Royal Licence of us, our heirs or successors for so doing first had and obtained, that then, and in any of these cases, this our present grant, and everything therein contained, shall cease and be absolutely void, and the lands and premises hereby granted, shall revert to and vest in us, our heirs and successors, as if this our present grant had not been made, anything herein before contained to the contrary in any wise notwithstanding." Now the perfect straightness of the pine, which has adapted it so eminently for this important use, and has caused it to be thus valued, depends upon the healthy growth of its leading shoot for a long succession of years. If this leading shoot is destroyed the onward growth of the tree is checked until one of the lateral shoots starts upward and becomes the leading shoot. But this causes a crook in the body of the tree at the place where this lateral shoot originally arose, and thus the main value of the tree is destroyed. And it would appear to be a spirit of pure malevolence that instigates the white-pine weevil to select the leading shoot of this tree in which to deposit its eggs, when its young can be nourished equally well in the lateral shoots, where they would do little injury, or perhaps would be a direct benefit to the tree by cutting off the ends of the branches, and thus promoting the upward growth of the main trunk.

The weevil deposits her eggs in the bark of the topmost shoot of the tree, dropping one in a place at irregular intervals through its whole length. The worm which hatches from these eggs eats its way inwards and obliquely downwards till it reaches the pith, in which it mines its burrow onwards a short distance farther, the whole length of its track being only about half an inch. But such a number of young weevils are usually placed in the affected shoots that many of them are cramped and discommoded for want of room. The worm on approaching the pith often finds there is another worm there, occupying the very spot to which he wishes to penetrate. He hereupon, to avoid intrusion upon his neighbor, turns downward and completes his burrow in the wood outside of the pith. Those also which enter the pith are often unable to extend their galleries so far as is their custom without running into those of others. When its onward course is thus arrested the worm feeds

upon the walls of its burrow until it obtains the amount of nutriment it requires and is grown to its full size.

The tree that is attacked continues its growth upward during the fore part of the season as usual, sending out from the summit of the shoot that is infested a leading shoot, with a number of lateral branches around its base. But the growth of these new succulent twigs is arrested, and they begin to wilt and wither about the middle of July, the worms having by this time become so large and mined and wounded the stalk below to such an extent that its juices are exhausted, and it fails to transmit any nourishment to these tender green shoots at the summit, which consequently dry up and perish.

If the affected shoot be now examined, little oval cells about 0.30 long, placed lengthwise of the stalk, will be discovered all along its center, so close in some places that their ends are in contact, and in other places more or less widely separated, with the intervening space stuffed with sawdust, whilst here and there in the wood on each side of the pith similar cells show themselves. In each of these cavities lies a white glossy worm, its body soft, plump, and curved into an arch, 0.30 long, and not quite a third as broad at its anterior part where it is broadest.

This *larva* is divided by transverse constrictions into thirteen segments, including the head, with the breathing pores forming a row of small round tawny yellow dots along each side. Its head is about half the width of the body, round, flattened, polished and horn like, tawny yellow, with an impressed line along its middle, a faint whitish line on each side parallel with this, and a more distinct transverse arched white line anteriorly, and a minute black dot on each side representing the eye; the mouth darker colored, with the points of the mandibles slightly projecting, these organs being black, triangular, and with exceedingly minute sharp teeth along their inner edge. The neck has two smooth pale tawny-yellow spots above. It has no feet, but their places are supplied by roundish elevations of the skin on the under side of the three segments next to the head. The surface shows a few very fine short hairs, particularly on the ends.

These larvæ change to pupæ and to perfect insects in their cells, the latter coming abroad mostly early in the spring. The short description at the commencement of this account will suffice to distinguish this weevil from all our other species. It varies in its length from 0.20 to 0.30. Dr. Harris thinks they are more than a year in obtaining their growth, but I am quite confident the eggs deposited in the spring become mature beetles by the following spring or earlier.

In midsummer, as soon as the shoot in which these insects are nestling becomes withered and dry, the thin bark covering it is commonly seen to be broken and peeled off in spots, or all its lower part is torn away, and newly perforated holes, larger than the mouths of the burrows of this insect, may be observed here and there in the wood. This is

the work of small birds, which are very efficient and serviceable in ferreting out and devouring the larvæ and pupæ of this weevil. And, in addition to these, it has several insect enemies which aid in restraining it from becoming excessively numerous. But notwithstanding the great inroads which are hereby made upon its ranks, this is quite a common insect in every part of our State and country where the pine abounds, deforming these valuable trees and retarding their growth. The proprietor of every grove of young pines should therefore make it a rule to examine them every year, in August or September, and cut or break off the top of every tree that is blighted by these weevils and commit it to the flames. With every shoot that is thus treated, from ten to fifty or more of these weevils will be destroyed, which otherwise will come abroad the following year to dwarf and deform a number of the other trees in the same manner. No one, on casting this subject over in his mind for a moment or two, will doubt but that a few hours devoted to such work, or a whole day, should it be required, will be time well spent, and labor that will be amply rewarded.

To the foregoing account, copied from Fitch's Fourth Report, we will only add that we have observed the weevil in all its stages of growth at Brunswick, Maine, under the bark of white pine shrubs, the last of April, the larvæ at this date being more numerous than the pupæ or beetles. Our larvæ were .32 inch long. The pupa is white, the tip of the abdomen being square, with a sharp spine on each side. It is .30 inch in length. There are often to be seen in the forests of Maine trees, from two to four feet in diameter, variously distorted by the attacks in early life of this weevil; one in particular, at Brunswick, we are familiar with, nearly four feet thick at the base, and which subdivides into eight shafts, the central one wanting.

We have also found the insect in abundance in September, on the ornamental pine bushes on the grounds of the Massachusetts Agricultural College, at Amherst, Mass.

59. THE WHITE-PINE APHIS.

Lachnus strobi Fitch.

Order HOMOPTERA; family APHIDÆ.

Colonies of plant-lice on the ends of the branches, puncturing them and extracting their juices, the bark of the infested trees having a peculiar black appearance; numbers of ants in company with them, and traveling up and down the trunks of the trees which they inhabit. The winged individuals 0.20 long to the tips of their wings, black, hairy, and sometimes slightly dusted over with a white meal-like powder, with a row of white spots along the middle of the abdomen, the thighs dull pale-yellow at their bases, and the fore wings hyaline, with black veins, of which the forked one is exceedingly fine and slender. The wingless individuals far more numerous, 0.12 long, brownish black with a white

line along the middle of the thorax and white spots along each side of the abdomen, which are sometimes faint or wanting, the antennæ pale, with their tips black.

60. THE PARALLEL SPITTLE-INSECT.

Aphrophora parallella Say.

Order HEMIPTERA (Homoptera); family CERCOPIDÆ.

In June, a spot of white froth, resembling spittle, appearing upon the bark near the ends of the branches, hiding within it a small white wingless insect having six legs, which punctures and sucks the fluids of the bark, and grows to about a quarter of an inch in length by the last of that month, and then becomes a pupa of a similar appearance, but varied more or less with dusky or black, and with rudimentary wings resembling a vest drawn closely around the middle of its body; the latter part of July changing to its perfect form, with wings fully grown, and then no longer covering itself with foam, but continuing to the end of the season, puncturing and drawing its nourishment from the bark as before. The perfect insect a flattened oval tree-hopper, 0.40 long, with its wing-covers held in form of a roof, its color brown from numberless blackish punctures upon a pale ground, a smooth whitish line along the middle of its back, and a small smooth whitish spot in the center of each wing-cover, its abdomen beneath rusty brown.

The reasons why I regard this species as pertaining to the genus *Aphrophora*, to which Say had assigned it, instead of the genera in which it has recently been placed, will be found stated under a kindred species in my Third Report, No. 98. (Fitch.)

What I suppose to be this insect is also very common on the pitch pine at Brunswick, Me. The pupæ are common late in July, but early in August the insects acquire their wings.

61. THE SARATOGA SPITTLE-INSECT.

Aphrophora saratogensis Fitch.

A similar insect with the same habits with the preceding, but differing from it in having the punctures uncolored, and the head above with its anterior and posterior margins parallel. It is of a lighter color than the foregoing, being pale tawny-yellow varied with white. It is much more attached to the pitch-pine than to the white pine, and is very common upon the small trees of that kind growing upon the sandy plains of Saratoga County. (Fitch.)

62. THE PITCH-PINE TWIG TORTRIX.

Retinia (?) *comstockiana* Fernald.

Boring into the twigs and small branches of the pitch-pine (*Pinus rigida*), causing an exudation of resin; yellow-brown larvæ, about 10^{mm} (.39 inch) long, transforming within the burrow, and giving forth small brown and gray moths. (Comstock.)

An examination of the pitch-pines in the vicinity of Ithaca, N. Y., in the early part of the past summer,* revealed the fact that they were infested to a considerable extent by a heretofore undescribed pest. Upon the smallest twigs and limbs and upon the terminal shoots of the trees were observed exuding at intervals masses of pitch, mixed with

*The account is copied textually from Professor Comstock's Report, 1879.

the excremental pellets of some larva. In most cases there were two distinct layers of the resin to be seen, the lower dry, hard, whitish, weather-beaten, having evidently been exposed during the winter, while the upper mass was fresh, softer, and of a hoary, bluish color on the surface, yellowish beneath, having the appearance of a comparatively recent exudation. These resinous lumps, when occurring upon twigs or limbs, were, in the great majority of cases, upon the upper side, and were seldom found upon a larger limb than the one represented in the cut.

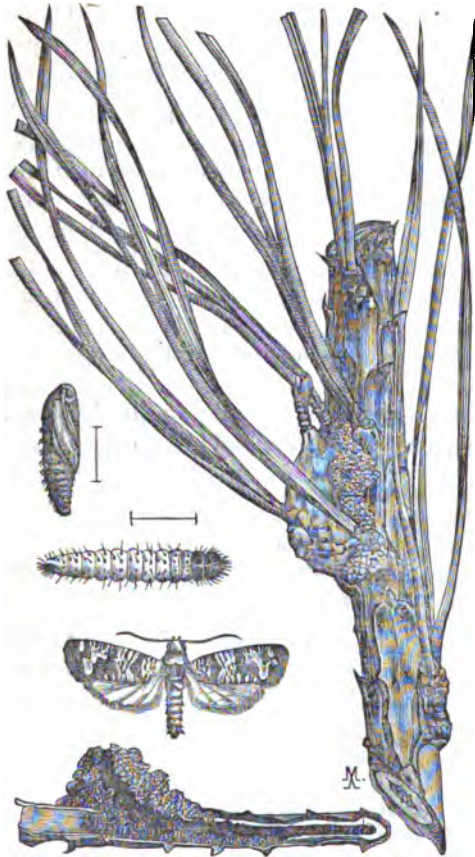


FIG. 81.—*Retinia comstockiana* Fernald, larva, pupa, adult and work.—From Comstock.

the empty pupa skin was protruding for half its length, the pupa having worked itself to that position before giving forth the moth.

Some of the burrows examined extended in both directions from the point of entrance. Occasionally, also, the twig at the point where the resin exuded was completely girdled, and in other cases eaten out to such an extent that a very slight force would suffice to break it off. The larvæ were in some cases found with their heads at the mouth of the burrow, but in the majority of instances the opposite was the case.

The moth which issues from the burrows is quite small and soberly colored. In the figure it is represented natural size; the darker shades

A longitudinal section through one of these lumps showed a channel of greater or less size leading directly to the heart of the twig, and extending along toward its base for a distance of from 25mm to 50mm (1 to 2 inches.) In this burrow was found a rather stout, yellowish-brown larva, apparently nearly full grown, and measuring about 10mm (.39 inch) in length. In other burrows the short, stout, brown pupæ were found. They were quite active, and retreated to the bottom of the mine when the resin was cut into. A ring of strong spines surrounded the posterior border of each segment and enabled them to move about in the mine with considerable rapidity. From other lumps

are dark rust color, and the lighter light gray. It belongs to the family Tortricidæ, the larvæ of which are usually leaf-rollers.

From what we have been able to learn, we conclude that there are two broods of this insect in a year, and that the second brood hibernates in the larva state. May 25, burrows were found from which the moths had already issued. In the breeding cages at Washington the moths issued until June 20, when the last one made its exit. August 23, larvæ were received which were nearly full grown, and were presumably of the second brood. In the following January nearly all the larvæ found were only about half grown; none were more than two-thirds grown.

At the approach of winter the larvæ prepare their burrows for hibernation by lining them with delicate layers of white silk, which often form tubes closed at the lower end. The larva remains through the winter with its head at the posterior end of the mine. Before the change to the chrysalis state, however, this position is reversed and the head is towards the opening.

Wherever a twig is pierced and bored by one of these larvæ the leaves begin to turn yellowish and the twig often dies. In many cases, however, more than one of the larvæ are to be found in a single twig, and this of course more certainly insures its death. It seems probable that the principal damage done is the disfiguring of the shape of the tree by the destruction of terminal shoots.

It is probably this caterpillar which in the summers of 1873-'74 proved very destructive to the pitch pine bushes in and about Brunswick, Me., causing the upper part of the bush to turn yellow and die.

The moths bred from the burrows were submitted to Professor Fernald, who decided that they represented a new species, probably belonging to the genus *Retinia*. This species he describes in the Canadian Entomologist, vol. xi, p. 157. We quote Professor Fernald's description of the moth, and append descriptions of the larva and pupa so that the insect may be recognized in whatever stage it is found.

The moth.—Head in front, basal joints of antennæ, and palpi white; last joint of palpi and a few scales upon the outside of the middle joint dark gray. Eyes black, vertex light sulphur-yellow to straw-yellow. antennæ dark brown, annulated with whitish. Thorax above white, with a few scattered gray scales; beneath silvery white. Abdomen above light brown, with a silvery luster; lighter at the end of each segment; beneath lighter; last segment in the females darker brown above and beneath, and without the silvery luster. Anal tuft in the males light straw color. Fore and middle legs light brown, femora and tibiæ of hind legs white, tarsi of all the legs brown, ringed with white. Fore wings ferruginous brown, the extreme costal edge from base to near the apex dark brown. A number of small white spots rest upon the costa, four hairs beyond the middle, from all of which stripes composed of

white and leaden-hued scales extend, more or less irregularly, across the wing at nearly right angles with the costa, and having something of a wavy appearance in some specimens, with some indication of a basal patch, a central and subterminal band composed of the leaden and white scales. Fringes light brown above and beneath; fore wings light brown beneath; ferruginous apically, with the white spots of the costa well indicated. Hind wings above and beneath grayish brown, with a tinge of ferruginous in some specimens and with darker irroration on the costa and outwardly; fringes long at the anal angle, somewhat lighter and with a darker line near the base.

Expanse.—Female, 18–20^{mm}; male, 18–20^{mm}. *Habitat*.—Ithaca, N. Y. Described from two males and three females.

I have provisionally referred this species to the genus *Retinia*, for although it agrees with the definition of the genus as given by Heinemann in other respects, the venation of the fore wing differs in the origin of veins four and five, which are not from the same point, but a little remote from each other; the distance between veins five and six at their origin is about twice the distance between veins four and five.

The moth has also been taken by Mr. Otto Lugger at Baltimore, Md.

Larva.—Length, when full-grown, 12^{mm}, cylindrical, tapering very slightly at the ends. General color yellowish; head, thoracic plate, and piliferous spots brown and highly polished; anal plate dusky and somewhat polished, under a high power covered with shallow pits. The piliferous warts are large and quite prominent, each bearing a stiff hair. Their arrangement is normal. The anal shield is furnished with two transverse rows of four hairs each; the posterior row, from a dorsal view, appearing to fringe the end of the body. The stigmata are light colored, surrounded by a dark-brown chitinous ring. Thoracic legs and bases of prolegs brownish.

The young larvæ differ in being darker colored. The head and thoracic shield are lighter; the piliferous spots are hardly discernible; the stigmata are much larger in proportion to the size of the larva, and their dark circumference is very strongly marked.

Pupa.—Length, 7^{mm}. General color dark shining brown, darkest on dorsum of thorax and head; wing-sheaths broad, extending to third abdominal segment. The posterior border of each abdominal segment dorsally elevated to a spiny ridge, bearing many strong backward-directed spines. Anal segment somewhat truncate, with a number of slender hooked filaments. Eyes very black and prominent. Between the eyes two pairs of the hooked filaments, having their origins close together and spreading. (Comstock.)

Two species of Ichneumonid parasites have been bred from the larvæ, both furnished with long ovipositors to pierce the resinous mass. One is a species of *Agathis*; the other is *Ephialtes comstockii* Cresson described in Mr. Comstock's Report.

64. THE PINE TWIG TORTRIX.

Retinia frustrana Scudder.

Order LEPIDOPTERA; family TORTRICIDÆ.

Infesting the new growth of *Pinus inops* and pitch-pine (*P. rigida*) (and perhaps of other species), spinning a delicate web around the terminal bud, and mining both the twig and the bases of the leaves; one or several small yellowish larvæ which transform within grayish cocoons, either in their burrows or fastened to the twigs, and become small copper-colored moths, with wing expanse of 12^{mm} (0.47 inch).

"About the middle of May, 1879, the scrub-pines (*Pinus inops*) in Virginia, near Washington, were found to be greatly injured by small lepidopterous larvæ. On many trees there was scarcely a new shoot to be found which was not infested at its tip by from one to four yellowish black-headed caterpillars. They were so completely concealed while at work that their presence would scarcely be noticed, and the effect of their work was hardly visible until the twig was almost completely destroyed. Upon close examination a delicate web was seen inclosing the base of the bud, and the surrounding new leaflets, resembling much the nest of a small spider. When this web was removed, one or several little yellow caterpillars were seen retreating into a mine in the bud or into the bases of the leaves, which were also mined, or, not infrequently, they dropped from the twig, suspending themselves by a silken thread. The bud was often so hollowed that it dropped to pieces almost at a touch.

"At the time when they were first noticed larvæ of almost all sizes were to be found. Some were apparently almost full-grown, while others had evidently not been long hatched. The nearly full-grown specimens measured 8^{mm} (0.31 inch) in length. The first pupæ were obtained early in June. Most of the larvæ transformed within the burrows which they had made, first spinning more or less of a silken envelope about themselves. Others, however, issued from their mines, and spun rather tough grayish cocoons between the leaves. The pupæ were short, stout, and brown in color, with each segment furnished dorsally with two serrated lines, one consisting of large and the other of fine teeth.

"The first moths issued June 13, the pupæ having previously worked their way, by means of the spines just mentioned, into such positions that they could give forth the moths without injury to the latter, and a few weeks later almost every shoot had one or more of the empty pupa skins protruding from it. Specimens of the moths were sent to Professor Fernald, who determined them as identical with Mr. Scudder's manuscript species *Retinia frustrana*. In August Mr. Scudder gave a short account of this insect before the entomological section of the

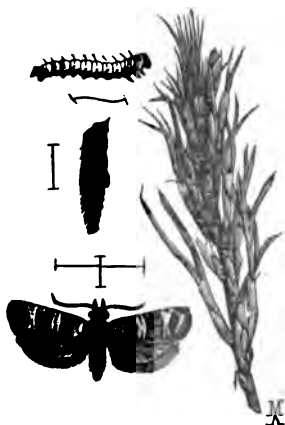


FIG. 82.—*Retinia frustrana* Scudder, larva, pupa, adult and work. —From Comstock.

American Association for the Advancement of Science, at Saratoga. He had found it in such numbers upon the island of Nantucket, in the young trees of *Pinus rigida* planted there some years ago to repair the damage done by burning during the war of 1812, as to seriously threaten the success of the experiment. Mr. Scudder intends publishing an account of the workings of the insect in that locality very shortly.

"In the latter part of July specimens of the twigs of *Pinus rigida* were received from Mr. S. H. Gage, of Ithaca, which had evidently been infested by the same insect, although no living inhabitants were to be found. In September other specimens were received from the same gentleman, and this time pupæ and one larva were found. According to Mr. Gage the insect is not very common in that locality.

"In the latter part of August individuals of the second brood were very abundant in the scrub-pine in the vicinity of Washington. As before, they were found in almost every stage of growth, and the difference was even more marked. In one instance five larvæ of greatly differing sizes were found in one shoot. The smaller ones were boring into the bases of the leaves, and the larger ones into the twig proper. The largest of the five had made quite a long channel from the tip of the bud down into the heart of the twig. Pupæ were also found at this time, which did not give forth the moth until late in the winter.

"The usual mode of hibernation is in the pupa state. A thorough search in January in the field showed only pupæ. The pupæ collected in August and September did not begin to give forth the moths in the breeding cages before early January, February, and March, and were greatly hastened without doubt by the heat of the room. On February 15, however, a few twigs were collected, from one of which, on February 28, a full-grown larva had emerged and was found crawling about the cage. This would seem to indicate occasional larval hibernation.

"As to remedies, the only one which I can suggest at present is that involving the somewhat arduous task of picking off the infested twigs in early winter and burning them. Whether the salvation of the trees will be worth this labor in greatly infested regions will depend entirely upon their value to those interested.

"As Mr. Scudder has prepared descriptions of all stages, we will not trespass upon his ground by appending further descriptions than we have already given. Our figure will assist in the recognition of the species."

65. THE PITCH-PINE RETINIA.

Retinia rigidana Fernald.

Order LEPIDOPTERA; family TORTRICIDÆ.

Inhabiting terminal shoots of *Pinus rigida*, and of similar habits to the Frustrating Retinia, a gray, brown, or blackish larva 8^{mm} ($\frac{1}{4}$ inch) in length, which in its perfect form becomes a small moth with dingy white wings, marked with dark red and silvery gray. (Comstock.)

"In the summer and fall of 1879 Mr. S. H. Gage, of Ithaca, N. Y., sent to the department specimens of the pitch-pine containing Tortricid

larvæ and pupæ, which in their work resemble *Retinia frustrana*, but differ from that insect in coloration and in being slightly larger. These developed into a moth intermediate in characters between *R. frustrana* and *R. Comstockiana*, and which has been described by Prof. C. H. Fernald as follows:

The moth.—Head sordid white, with a yellowish tinge; front and palpi inclining more to ashy; antennæ brown, annulated with white; thorax above very light gray, washed with dull ochreous, deepening to a coppery tint on the front of the patagiæ.

Thorax beneath, abdomen and hind wings above and beneath, and fore wings beneath light gray, with a silky luster; fringes of the hind wings lighter, with a line near the base concolorous with the wings.

Fore wings above sordid white, with a basal patch occupying the basal fourth of the wing, composed of about four irregular cross-streaks of dark red, alternating with similar streaks of silvery gray, the outer red streak sending out a tooth on the fold. The light space following the basal patch has several small gray costal spots, from which light ochreous streaks extend across the wing. A dark-red band extends across the wing beyond the middle, divided on the costa by a geminate white spot. Below the cell the basal half of the red band is replaced by stripes of light ochre-yellow and silver-white; the remaining portion of the red band below the cell is curved outwardly, making this part convex on the outside and concave on the side towards the base.

The apical portion of the wing is dark red, changing to bright ochre-yellow inwardly, and towards the anal angle divided by a subterminal geminate broken line of silvery scales, extending from the costa to the anal angle.

Fringe reddish-purple. The costa from the basal patch to the terminal band is marked with geminate white spots, alternating with gray.

Posterior femora and tibiæ very light silky gray; fore and middle femora and tibiæ gray, with coppery reflections, the tibiæ banded with white. All the tarsi gray, with whitish tips.

Expanse.—Female, 18^{mm}. *Habitat*.—Ithaca, N. Y. Described from two females, one in the collection of the Department of Agriculture, the other in my collection."

AFFECTING THE LEAVES.

66. ABBOT'S WHITE PINE SAW-FLY.

Lophyrus abbotii Leach.

Order HYMENOPTERA; family TENTHREDINIDÆ.

From mid-summer until October, and sometimes as late as November, clustering on the twigs and smaller branches of the white pine, soft, smooth-bodied, yellowish-white worms about an inch long, with three, and posteriorly four, longitudinal rows of large black dorsal spots; late in the autumn transforming in tough brown pod-like cocoons attached to the twigs, within which they hibernate, changing to pupæ (in Illinois) about the middle of May, the 4-winged fly with broad pectinated antennæ appearing about the first of June. (Riley.)

By far the most destructive insects to the foliage of the pine and fir are the different species of false-caterpillar or larvæ of the pine saw-fly or *Lophyrus*. When present at all these larvæ exist in colonies, keeping together until they are ready to undergo the chrysalis state; and after stripping the leaves of one twig or small branch pass on to adjoining twigs until a large branch or nearly one side of a tree will be denuded

of leaves. Such effects we have often seen in isolated pitch-pine trees in the woods of Maine. Still more destructive are these larvæ to plantations of young pines on Cape Cod, where, if not prevented, they may strip tree after tree of a young growth of seedling pines. Moreover, an allied species (*L. lecontei*) is annoying to the ornamental Austrian pines and Scotch firs on lawns and in shrubberies, so that we have placed these insects near the head of those destructive to the leaves of coniferous trees.

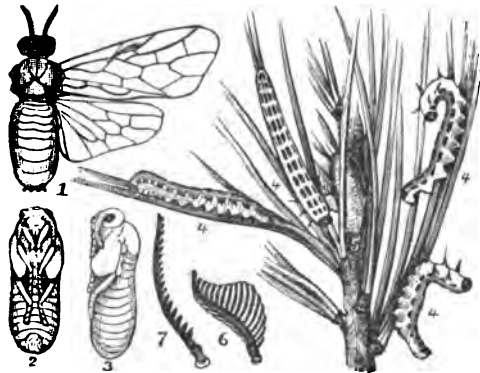


FIG. 83.—Abbot's white pine saw fly; 1, female, enlarged; 2 and 3, pupa, enlarged; 4, larvæ, natural size; 5, cocoon, natural size; 6, male, 7, female, antenna enlarged.—After Riley.

Mr. W. C. Fish writes me that worms which I have identified as being of this species do "much mischief among the pines on Cape Cod. These pines are small, having been growing but from six to twelve years from seed planted by the farmers in order to renew the soil on their poorer lands. Whole acres of these small pines are (1868) being destroyed by this insect. Their habits are very similar to those of the fir saw-fly, *Lophyrus abietis* of Harris, though they are more gregarious than he describes that species to be. They eat the needles down to their insertion, thus stripping one twig after another. The larvæ spin their cocoons among the leaves, and the flies appeared about the middle of August. Out of thirty-one individuals but one was a male."

Professor Riley, in his Ninth Report, states that this saw-fly in its larval state is destructive in Indiana, Illinois, and Wisconsin. He states that the perfect insects are quite irregular in coming out of the ground, many of them issuing in May, but others not until toward the end of summer. "On opening cocoons that had passed the winter I have found many yet containing the larva the latter part of June, while others of the same brood had become flies six weeks before. * * * In ovipositing the female saws beneath the epidermis on one of the flat sides of the leaflets, and pushes into the slit an egg, which is whitish, ovoid .03^{mm} long, on an average. As the egg swells it forms a conspicuous bulging of the epidermis, and the mouth of the slit opens and exposes more and more a portion of the egg." It is preyed upon by an ichneumon fly (*Limneria lophyri* Riley).

Larva.—Average length 0.80 inch, though many will measure an inch. A soft, dingy-white worm, having often a greenish or bluish line superiorly. On all joints but the first, which is entirely white, two oblong square black spots along the back, and another somewhat rounder spot each side; these become somewhat diffused on the three latter joints, forming on the last a single black patch. Three black thoracic legs; fourteen abdominal and two caudal prolegs. Thoracic joints largest; the three last smallest and tapering. Some are marked very regularly, while in others the white

space on the back between the spots on segments 5, 6, 7, and 8, is much wider than between the others. This is probably a sexual difference, since those thus marked are shorter, thicker, and of a yellower white than those regularly marked. After each change of skin the head is at first white like the rest of the body, with the usual eye-spots black. No markings while young.

67. THE FIR SAW-FLY.

Lophyrus abietis Harris.

Defoliating the leaves of the fir, spruce, as well as the pitch-pine, larvæ similar to the foregoing, the flies appearing late in July and also early in May. (Harris.)

The following account of the fir saw-fly is taken from Harris's Treatise: "For some years past many of the fir trees, cultivated for ornament, in this vicinity, have been attacked by swarms of false-caterpillars, and, in some instances that have fallen under my notice, have been nearly stripped of their leaves every summer, and in consequence thereof have been checked in their growth, and now seem to be in a sickly condition. My specimens of this kind of saw-fly, which were raised from the caterpillars in the summer of 1838, came out of their cocoons towards the end of July in the same year; but I have also found them on pines and firs early in May."

To this account Dr. Fitch makes the following comments:

"I suspect Dr. Harris's observations upon this species were not full, and that like the analogous saw-fly which we have noticed on the pine, No. 273, there are two generations of this species annually; for we are informed that the perfect insect appears in May, producing a crop of worms in June and July, from the cocoons of which the perfect insect come out the last of the latter month. But Dr. Harris supposes that most of these cocoons remain unhatched through all the hot weather of August and September and the winter succeeding, to give out the flies which appear in May. It is much more probable, however, that the flies all come out of their cocoons about the beginning of August, and like the species we have seen on the pines, produce another brood of worms in autumn, which has escaped the notice of Dr. Harris; and it is these which lie in their cocoons through the winter and give out the flies which are met with in May."

The male saw-fly is smaller than the female, with broadly pectinated antennæ, and is $\frac{1}{4}$ inch in length; body black above and brown beneath, legs dirty leather-yellow color.

The female is about three-tenths of an inch long; body yellowish brown above, with a short blackish stripe on each side of the middle of the thorax; body beneath and legs paler, of a dirty leather-yellow color: antennæ short, tapering to a point consisting of 19 joints, and toothed on one side like a saw. (Harris.)

68. LE CONTE'S SAW-FLY.

Lophyrus lecontei Fitch.

Clusters of dirty yellowish, black-spotted false caterpillars on the outer branches of ornamental pines and firs on lawns, stripping the leaves and disfiguring the shrubs.

Dr. Fitch described under the above name this saw-fly, but did not rear it from the larva, though inferring that it was the parent of certain

false caterpillars, of which he found two broods on "pines, particularly those set in our yards for ornaments, stripping the limbs which they invade of their leaves." He further says, "When nearly mature these worms are so large that the end of a single leaf of the pine probably furnishes them a very insufficient mouthful, hence two worms often unite, standing face to face, and thus hold the five leaves which grow from each sheath on the white pine pressed together in a bundle as they eat them, commencing at the tip and gradually stepping backward as the leaves become shorter. It is only the old leaves of the previous year's growth which these worms consume, never touching the new ones at the outer end of the limb; hence they injure the tree much less than they would were they to strip the limbs they invade of the whole of their foliage. At least two broods of these worms appear annually, the one in July, the other in September and October, the latter often remaining on the trees after frosty nights have occurred. Having finished feeding, they leave the tree and inclose themselves in cocoons under fallen leaves or other shelter on the surface of the ground, in which they remain during their pupa state."

The female.—Length, 0.33 inch to the tip of the abdomen and 0.43 inch to the end of the wings. It may at once be distinguished from all our other described species by the joints of its antennæ, which are 21 in number. It is shining dull, tawny yellow, with the antennæ black, and also the abdomen and base of the thorax. The under side is paler yellow, with two broad black stripes on the abdomen. The wings are smoky hyaline, their veins black. Captured the middle of May. (Fitch.)

Riley states that this saw-fly has been found feeding on the Scotch and Austrian pines in New Jersey. The larva he describes as an inch long, dirty or yellowish white, with dorsal black marks wider before than behind, and usually broken transversely in the full-grown individuals. They are further apart than in *L. abbotii*. The lateral spots are somewhat square, with an additional row of smaller black marks below them, and the last segment is entirely black above.

The antennæ of the male fly are twenty-one-jointed, and have on one side seventeen large and on the other seventeen small branches, there being eighteen on one side and fifteen on the other in *L. abbotii*. The female may at once be distinguished from *L. abbotii* by her abdomen being jet black above, with a small brown patch at the end and a transverse line of the same color just below the thorax.

Besides the species of *Lophyrus* above mentioned there are four other species of this genus, which probably live on coniferous trees, and also the following species known to infest the pine.—*Lophyrus pinetum* Norton (female, with 19 antennal joints, on pine, Norton in Packard's Guide, p. 226).

Remedy.—These saw-flies, living as they do in societies in large masses of coarse castings like sawdust, are easily detected by the eye, and can readily be removed by hand, especially in the case of ornamental shrubs.

69. THE PITCH-PINE SAW-FLY.

Lophyrus pini-rigide Norton.

With the general habits and appearance of the preceding species, but so far as yet known confined to the pitch-pine.

This saw-fly was described by Mr. Norton in our "Guide to the Study of Insects." The larvæ are allied to those of *Lophyrus abietis*, and during one summer ravaged the young pitch-pines, which had been raised from the seed on a plantation at Eastham, Mass., on Cape Cod. The female lays her eggs singly in one side of a "needle" of the pine, though sometimes an egg is inserted on each side of the leaf.

Female.—Length, 0.30; expanse of wings, 0.65 of an inch; antennæ 17-jointed, short, brown; color luteous brown, with a black line joining the ocelli; a black stripe down each of the lobes of the thorax above and the sutures behind; body paler beneath; the trochanters and base of the tibiæ waxen; claws with an inner tooth near the middle; wings very slightly clouded; cross nervure of the lanceolate cell straight.

Male.—Length, 0.25; expanse of wings, 0.55 of an inch; antennæ fifteen-jointed, black, quite short, with twelve branches on each side, those at the base nearly as long as the sixth and seventh; apical joint simple, enlarged at base; color of insect black, with the abdomen at apex and beneath yellow-brown; legs the same color at base; below the knees whitish. The male looks precisely like that of *L. abietis*, but the form of the antennæ is different, being much shorter. The female looks much like *L. abdominalis* Say, taken on the pine near New York. (Norton.)

Mr. W. C. Fish wrote me some years ago from Eastham, Mass., as follows regarding this insect and the attacks upon it by the white-winged crossbill: "In the fall of 1868 there was a second brood of the larvæ of *Lophyrus pini-rigide* Norton. On the 16th of September I noticed a few nearly grown, but the greater part of those seen at that date were very small. On the 15th of October I noticed large flocks of the white-winged crossbill hovering over and alighting upon the young pines that were infested with these larvæ. There were certainly three or four hundred birds in some of these flocks. I soon learned that they were feeding upon the larvæ, as I had many opportunities to watch them while feeding among the trees. I also took numbers of the larvæ from the stomachs of several individuals that I shot.

I had one in confinement several days, feeding it with these larvæ. Those out of doors seemed to discard the head and harder legs of the larvæ, but the one in confinement swallowed the insect entire. These birds were abundant through November and December, and more or less common all winter. Some of the larvæ were found quite late in November after we had experienced severe freezing weather. I saw them frozen stiff several times.

On the 27th of November, I took several into the house, where they

spun their cocoons and the saw-flies came out the next spring. So well did the crossbills do their work that the *Lophyrus* was rare the next summer (1869). If this wholesale destruction of the larvæ had not occurred, there would have been acres of young pines destroyed.

"I did not meet with the red crossbill until January, when I met a flock at Sandwich; in February I met a flock here (Eastham). Neither of these birds are common visitors to the Cape. I have not known of any visiting us the past winter. I never met with one until 1868, but residents of Eastham informed me that the white-winged species was with them in the fall of 1867. An old lady in East Falmouth informed me that a number of years ago they visited her orchard and damaged her apples by cutting them off to get the seeds."

70. THE LYDA SAW-FLY.

Infesting the Austrian pine, tying the needles together with a silken web filled with castings, forming a mass about six inches in diameter, with the needles of the pine scattered through the mass, the leaves being separated by the false-caterpillars from the branch.

We have noticed this false-caterpillar on but a single occasion, and then failed to rear the worms to the winged state. The following account is taken from our article entitled "Injurious Insects, New and Little Known," in the Report of the Massachusetts Board of Agriculture for 1870 :

Late in September of 1869 Dr. William Mack, of Salem, Mass., brought into the museum of the Peabody Academy of Science, some singular

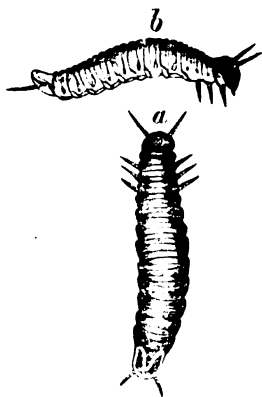


FIG. 84.—Lyda saw fly larva on Austrian pine, enlarged.—From Packard.

false-caterpillars which had assembled on a single branch of an Austrian pine, on his place, and had tied the needles together with a fine silken web filled with castings, forming a mass of castings about six inches in diameter, with the needles of the pine among them, the leaves being separated by the larvæ from the branch.

The larva is that of a species of *Lyda*, and while doing little injury to the tree, so far as known, yet merits a short description. Dr. Ratzburg figures a similar species in his work on forest insects, and states that the *Lyda campestris* of Europe, to which our species seems closely allied, is sporadic in its attacks on the pine and never proves very destructive.

The larva.—The body is cylindrical, a little flattened, and thickest in the middle, with small thoracic slender legs, which are not used much in walking, the larva wriggling along when placed on a smooth surface. The head is pale reddish with a black spot between the antennæ; the prothorax is black above and the body reddish olive-green, with a rather broad purplish line along the middle of the back. There are no abdominal legs, and the end of the body is somewhat flattened, with a black round spot on each side of the anal plate; beneath is a broad transverse incision.

Below, and arising from each side, is a long, corneous, three-jointed, slender outstretched appendage of the size and form of the antennæ. The under side of the body is mottled with greenish and reddish as above, with a reddish medium line. On the side of the thorax are two rows of dots, and two rows along the middle on the ventral side of the three thoracic wings.

71. THE PINE THECLA.

Thecla niphon (Hübner).

Order LEPIDOPTERA ; family PAPILIONIDÆ.

Feeding upon the leaves in summer, a flattened oval worm, 0.75 long when full grown, of the same deep green color as the leaves, with a light yellow stripe along the middle of its back and a white one on each side, and a brown head; changing to a short thick grayish pupa with two rows of small blackish spots, and outside of these a row of more conspicuous rust-red ones, which is attached by its tail and by a thread around its middle in form of a loop; giving out a smallish butterfly which comes abroad in April and the fore part of May; 1.00 to 1.15 in width across its wings, which are of a dusty rust color and without spots above, paler grayish beneath, the fore ones with a dislocated black band beyond the middle, edged on its hind side with snow white, and beyond this a row of black crescents, each with a white spot in its concavity, and the hind wings similarly but more complexly variegated. (Fitch.)

Boisduval says, "This insect lives in Georgia and Florida, on several species of pine, and is very rare and seldom seen in collections." It, however, is a common species in the State of New York, in all our forests where pine trees abound, coming out with the first warm days of spring, before collectors are much abroad in search of insects; and continuing but a short time. (Fitch.)

72. THE SOUTHERN PINE HAWK-MOTH.

Ellema coniferarum (Smith).

Order LEPIDOPTERA ; family SPHINGIDÆ.

Feeding on the pine in the Gulf States, a caterpillar with a short caudal spine, the body checkered with brown and white spots, with a dorsal whitish line; entering the earth to transform into a small gray sphinx moth, closely resembling the two following northern species. (Harris.)

73. HARRIS' PINE HAWK-MOTH.

Ellema harrisii Clemens.

A grass-green caterpillar with no caudal horn, but a caudal plate granulated and edged with white, with yellow subdorsal and lateral bands, and a white stripe bordering the stigmata; becoming fully bred and leaving the white pine about the middle of September, the pupa subterranean, and the moth appearing about the middle of June in New York. (Lintner.)

The different pine hawk-moths are of little economic importance, as they are of great rarity both in the caterpillar and moth states; but from a scientific point of view these moths possess much interest.

Larva.—2 inches long, .23 inch broad. Subcylindrical, tapering slightly anteriorly, and the last two segments quite tapering. Head, size of first segment, granu-

lated, flattened anteriorly, subtriangular, with an impressed medial line, and straight yellow lateral lines terminating at the apex in two black granulations, and bordered interiorly above with black. Body grass-green. Subdorsal and lateral bands yellow. Substigmatal stripe bordering the stigmata, white, enlarged on the central portions of the segments. Between the subdorsal and substigmatal stripes, on the fourth and fifth segments ventrally, and exteriorly to the legs and prolegs, dotted on the segments with paler green or yellow. On the vascular line a series of crimson spots on the front of the segment, beginning usually on the fourth, the first small, sometimes double, the anterior ones triangular or lozenge-shape, regularly increasing in size and extending over more of the segment, the posterior ones quadrangular, and uniting on the last two segments in a stripe. A ventral stripe of rose color, beginning at the third pair of legs, widening as it proceeds, and embracing the prolegs. No caudal horn. Caudal shield granulated and edged with white. (Lintner, Proc. Ent. Soc., Phil., iii, 669.)

Pupa.—Chestnut-brown, with a rough, not produced head-case. Tongue-case buried, parting the leg-cases, but terminating just before reaching the tips of the wing-cases. Incisures rounded. Posterior segments tapering. Stigmata black, terminal spine black, contracted at base, minutely bifid. Length, .95–1.10 inch. (Lintner.)

74. THE CHECKERED PINE SPHINX CATERPILLAR.

Ellema pincum Lintner.

A caterpillar like the foregoing, but with a dorsal row of squares, and transforming to a moth which is readily distinguished from *Ellema harrisii* by the darker ground-color of its wings, the absence of the gray shades, and its much less distinct markings. (Lintner.)

Mr. Lintner, in his Entomological Contributions contained in the 23d Report of the New York State Cabinet, describes the male and female of this pine sphinx, and also describes the larva as follows:

Larva.—Length two inches. Color grass green. Head subtriangular, green, bordered with bright yellow, within which, at the apex, is a $\wedge$ of black. Body subcylindrical, tapering at the extremities, and without a caudal horn. Dorsally, a reddish-brown line interrupted on the hinder portion of each segment by a square of green traversed by diagonal lines; a subdorsal yellow line borders the above; lateral stripe yellow; substigmatal stripe white, interrupted at the sutures by light green; ventral stripe and prolegs rose-red. Feeds on the white pine, and matures about the middle of September, when it enters the ground and forms a cell, where it becomes a chrysalis.

75. THE LARGE SPINEY CATERPILLAR.

Eacles imperialis (Drury).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Among the leaves of the white pine in the Northern States, late in August and through September, a large, thick, pale-green caterpillar between three and four inches long, with the head and legs pale orange, with six thorny, yellow knobs behind the head; pupating in the ground and changing late in June to a large, handsome, yellow moth, speckled with brown, and with a very light purple-brown band across the outer margin of each wing.

The transformations of this moth were first described by Harris, but the earlier stages have more recently been fully described by Mr. Lintner, in his Entomological Contributions, No. II. Though usually feeding on the white pine in the New England States, where we have seen it in the breeding-cages of entomological friends, it also feeds on the oak, button-wood, etc., and will eat the leaves of the chestnut. It is too rare to be of any economical importance, but will always attract the attention of lovers of fine, rare insects. The moth lays its eggs late in June, hatching in about a week or ten days; the larva, according to Lintner, molting at least four, if not five times.

Larva.—Three or four inches long and more than half an inch in diameter, and for the most part of a green color, slightly tinged with red on the back, but many of them become more or less tanned or swarthy, and are sometimes found entirely brown. There are a few very short hairs thinly scattered over the body; the head and the legs are pale orange colored; the oval spiracles are large and white, encircled with green; on each of the rings, except the first, there are six thorny knobs or hard and pointed warts of a yellow color, covered with short black prickles; the two uppermost of these warts on the top of the second and of the third rings are a quarter of an inch or more in length, curved backwards like horns, and are of a deeper yellow color than the rest: the three triangular pieces on the posterior extremity of the body are brown, with yellow margins, and are covered with raised orange-colored dots. (Harris.)

The pupa.—Subterranean, not contained in a cocoon, about two inches long, of a dark chestnut-brown color, rough, with little elevated points, especially in front; the end of the body with a long forked spine, and surrounded, on each ring, with a notched ridge, the little teeth of which point towards the tail. Three of the grooves or incisions between the rings are very deep, thus allowing a great extent of motion to the joints, and these, with the notched ridges and the long spine at the end of the body, enable the chrysalis to work its way upward in the earth, above the surface of which it pushes the fore part of its body just before the moth makes its escape. (Harris.)

The moth is ochre-yellow, spotted with purple-brown, with a large patch at the base, a small round spot near the middle, and a broad, wavy, light purple-brown band toward the outer edge of each wing; in the males there is another purple-brown spot covering nearly the whole of the outer hind margin of the fore wings, and united to the band near that part; the body is yellow, washed with purple-brown along the back. It expands from four and a half to over five inches. (Harris.)

76. *Cithronia sepulchralis* Grote and Robinson.

Closely allied to *C. regalis* is the above named species, whose caterpillar feeds on the pine. It is closely allied to the larva of *C. regalis*, but the horns on the three thoracic segments are paler, slenderer, and unicolorous, "the lower lateral pair on the third and fourth segments apparently greatly reduced; the specimens not being quite perfect prevents certain accuracy as to this latter statement." (Grote.) It is possible that this will be found to be a variety of *C. regalis*.

77. THE WHITE PINE TUFTED CATERPILLAR.

Platyserura furcilla Packard.

Found rarely in September on the white pine, a dull-red caterpillar, banded with brighter red; a white lateral line, with reddish hairs in clusters, and on the 1st, 3d, 4th, and 11th segments two long pencils of red hairs; spinning a cocoon among fallen leaves, the gray moth appearing about the middle of June.

This is another interesting caterpillar, whose history has been traced by Mr. Lintner. The worm, when in the attitude of feeding, with its terminal pair of legs clasps the leaves at the sheath, and extends its body along a leaf until it commences to bend, when, by detaching successively the first and following pair of prolegs, it forces the leaf through its legs until its tip is held between them. The caterpillars spin their cocoons beneath leaves lying in the bottom of the breeding-cage, the moth emerging June 12. It is interesting to see that this, like several other caterpillars of the pine in this country and Europe, are colored red like the pine shoots, and are thus perfectly protected from their enemies.

The caterpillar is an inch and five-eighths long. Head round, of about the diameter of the body, red, with conspicuous markings upon the front of lighter red, somewhat in the form of a script x, and less distinct reticulations of the same. Body presenting a peculiarly mottled appearance from its irregular and broken stripes; its general color dull red; on each segment an irregular band of brighter red; a whitish vascular line within a broken gray stripe; a better defined lateral stripe just above the stigmata, within which, on each segment from the third to the eighth inclusive, are four black depressed spots arranged in a right angle, the upper three in line, the largest of which rests on the crown of the segment, with two behind it and one before; the sub-stigmatal fold is white on the anterior portion of each segment and red on the remainder; rows of tubercles, from which clusters of red hairs of unequal length proceed, which, on the anterior segments, incline to yellow; on the 1st, 2d, 4th, and 11th segments each, superiorly, are two pencils of red hairs, nearly $\frac{1}{4}$ inch in length, darker at the tips, and slightly feathered. These pencils made their appearance after the last molting. Stigmata encircled with brown. Legs red. (Lintner.)

The moth has, compared with other Notodontians, rather broad triangular fore wings, rounded hind wings, the front of the head being rather broad and smooth, while the antennae are rather long and pectinated. It is ash-white, peppered with dark scales; the fore wings are crossed by a twice angulated basal black line, and near the insertion of the wing is a black spot. A second straight line crosses the wing just before its middle, and from it branches at nearly right angles a line which becomes straight above the second median nervule and parallel to the inner line, thus inclosing a large square area which is concolorous with the rest of the wing. There is a submarginal obscure line shaded with white externally, which is irregularly zigzag, and runs down more than usual in the second median interspace toward the margin of the wing. Length of body, .65 inch; expanse of wings, 1.50 inches.

73. THE PINE PARORGYIA.

Parorgyia parallela Grote and Robinson.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Occasionally found feeding during June and also in October on the pine, a caterpillar tufted like the vaporor moth (*Orygia leucostigma*), but with mouse-colored feathered hairs; the pencils black; cocooning July 5 and the moth appearing July 21. (Lintner.)

The following account of this not common insect is taken from Lintner's Entomological Contributions, iii. He has found it on the plum, and on one occasion (September 24) on the pine. His description was based on specimens reared in the breeding-cage from eggs laid July 25 in confinement. They developed fully by the first week in November,

when they assumed a fixed position on newly-spun thin webs a little larger in extent than their bodies, on which they went into their winter rest.

The caterpillar is as briefly described above. The moth, when at rest, folds its wings like the roof of a house, with its front legs extended, giving it an attitude like *Eudryas grata*.

The moth (female) is a large thick-bodied moth, with short, broad wings and heavily pectinated antennæ. It is named from the dark parallel longitudinal stripes on the upper surface of the fore wings. The fore wings are pale olive-ash, much clouded with brown and with scattered dark scales. The basal half of the front edge of the wing is olive-ash; the median vein is dark; below a broad black longitudinal stripe runs from the base of the wing out towards the outer edge. The inner median line is dentate, while the outer is distinct, black and scalloped. Marginal line brown. It expands 2 inches. (Grote and Rob.)

79. THE YELLOW BEAR.

Spilosoma virginica Fabricius.

This omnivorous caterpillar I have found feeding on the pitch-pine the first of September in Maine.

80. THE PINE MEASURING WORM.

Paraphia subatomaria Guenée.

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding on the pine, a brown measuring worm, the moth appearing June 24. (Saunders.)

The caterpillar of this moth is not known farther than that its color is brown.

The moth is a delicate species with deeply serrated and angulated wings. The present species differs from the others of the genus by its whitish color, being rarely somewhat ochereous, while the base and outer edge of the fore wings are as pale as the middle portion; the under side of the wings are rather pale. The wings expand 1.30–1.70 inches.

81. THE RED STRIPED PINE MEASURING WORM.

Cleora pulchraria Minot.

Occurring on the pine, a red striped measuring worm, changing to a delicate whitish moth with full rounded wings. (Saunders.)

This caterpillar is probably another instance of protective mimicry, being striped with red, and thus assimilated, probably in color, to the red twigs of the pine among which it feeds. It, like the foregoing, has been reared by Mr. Saunders, of London, Canada.

The pupa is rather thick, white, with a broad light-brown band along the back, becoming widest in the middle of the body. There is also a narrow brown band along the side of the body, and on the under side of the abdomen are four longitudinal stripes of the same color. The wings are slashed with light brown, and the antennæ

and fore legs are concolorous, while the middle and hind legs are white. Length, 0.44 inch.

The moth has unusually broad transparent wings, which are white or pale ash. Head deep yellow. Fore wings crossed by two black lines, the inner with four scallops, the outer line sinuous, scalloped, with a great curve outward between the subcostal and the third median venule. Opposite the discal dots are three acute, smaller scallops, all of equal size. Fringe whitish, distinctly checkered with black on the ends of the venules. Hind wings with a scalloped outer line, often obsolete toward the costal edge, varying in its distance from the outer edge; beyond this line the wing is darker than at the base. Expanse of wings, 1.30 inches. Its range as far as known is from Maine and Canada to the Middle States.

82. THE 10-LINED PINE SPAN-WORM.

Order LEPIDOPTERA; family PHALENIDÆ.

Larva.—Body $\frac{1}{4}$ inch in length, dull green, darker than the leaves; body very slender; head large, considerably wider than the body, deeply divided by the median line; pale greenish yellow. Body on the upper side with ten narrow linear wavy dull purplish livid lines, which disappear before reaching the supra-anal plate, which is small, flattened, not prominent; it is subtriangular in form, the apex not sharp. Similar purplish lines on the under side of the body. Thoracic and first pair of prolegs purplish; the last pair greenish. This though not a strictly mimetic form, is sufficiently so to escape ordinary detection, not being much darker than the leaves. Observed, August 17, on leaves of the pitch-pine at Brunswick, Me.

83. THE RED AND YELLOW STRIPED PINE SPAN WORM.

Feeding in September on the leaves of the pitch-pine, a stout reddish brown measuring worm, striped with straw-yellow; the moth unknown.

This is another reddish caterpillar which is somewhat assimilated in color to the pine twigs among which it feeds. Unfortunately the moth is unknown. We have found it the first of September, at Brunswick, Me., and also September 20, at Amherst, Mass.

The caterpillar is thick-bodied and rather short. Head large and smooth, not tuberculated above, but swollen somewhat on both sides. The sides of the body are swollen, and there is a lateral tubercle on the side of each segment; the anal lateral plates are large and spreading; the dorsal anal plate large, rounded at the end, and semi-elliptical rather than rounded. It is reddish brown, with minute straw-yellow lines; a pale straw-yellow median dorsal line dilating on each wing; a pair of dark brown dots on the hind margin of each segment; on the sides an irregular deep yellow line. Head reddish, dusted with yellow and dark brown speckles. Length not quite .70 inch.

84. THE PINE-NEEDLE SPAN WORM.

Feeding on the leaves, a small measuring worm, closely mimicking the form of a dead red-pine needle.

This is the most striking case of mimicry we have seen on the pine; the caterpillar, as it stands out stiff, holding on to the twig with its hind feet, after the manner of measuring or span worms, would easily be mistaken for a dead, dry, red pitch-pine needle! We have found one specimen on the pitch-pine at Brunswick, Me., September 1. On the 5th it made a slight silken white cocoon and assumed the semi-pupa condition.

The caterpillar is slender and unusually flattened, tapering more than is common towards each end of the body. The head is small and narrow, but rather full. The

color and form of the body is surprisingly like a dead red needle of the tree; it could readily be mistaken for it, since the end of the body suddenly tapers like the pine-needle itself. Color rust red, a darker dorsal line.

85. THE SNOUT MOTH CATERPILLAR.

Order LEPIDOPTERA; family PYRALIDÆ.

Larva.—Body with ten pairs of prolegs; body pale green, concolorous with the leaves on which it feeds; head small, much narrower than the body, of a very pale amber color; a faint dorsal and two subdorsal linear pale lines. Lateral ridge pale yellow. Each segment above with four black minute papillæ arranged in a trapezoid, and two on the side. All the legs concolorous with the body. Occurred August 17, on pitch-pine at Brunswick, Me.

86. Another span worm, living on the moss on pine trees, and found alive in Cambridge, Mass., in January, by Mr. Hill, is closely assimilated in color to the moss itself. Also we have found a handsome noctuid caterpillar (87) on the pitch-pine at Salem, Mass., which is red, marked with yellow, and would be readily overlooked from its mimicry of the red twigs of the pine. It may be the larva of a species of *Trachea*, and may represent the *Trachea piniperda* of Europe.

88. THE PINE TUBE-BUILDER.

Order LEPIDOPTERA; family TORTRICIDÆ.

Cutting off the ends of white pine needles, and spinning together a tube of the stumps, in September, and also to be met with probably early in summer, a pale-green leaf-roller, pupating late in September.

About ten years ago I found, in September, on the young white pines in the grounds of the Massachusetts Agricultural College, at Amherst, Mass., numerous pretty tubes such as are figured in the adjoining engraving. The larva, probably in August and early in September, gathers together about fifteen needles of the white pine, tying them into a bundle by silken threads; then, usually eating off about one-third of the ends, forms a tube, within which the worm lives.

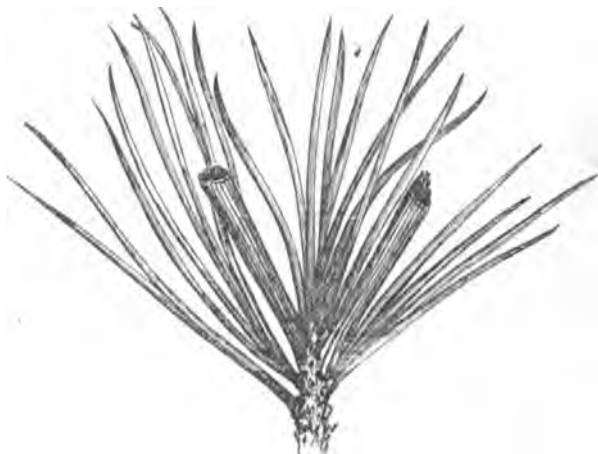


FIG. 85.—Tubes of the pine tube-building leaf-roller; natural size.—After Packard.

Some full-grown larvæ were found September 22 which had gathered the leaves together without cutting them off, the tube extending the whole length of the leaves. It is possible that the larvæ of the first brood early in summer cut off the ends of the tube, while the approach

of cold late in September prevents those of the second brood from giving the finishing characteristic touches to their tubular domiciles.

The larva is .30 inch long, pale green, a little paler than the pine leaves; darker over the region of the digestive canal. Body with minute warts of the same color as the body, from which arise short, slender, pale hairs. Head pale horn color, with a darker somewhat reddish patch on each side of the head; on the clypeus just behind the labrum a triangular spot; labrum reddish horn color. It is very active, climbing out of its tube and letting itself down by a thread when disturbed. The worms found at the end of September were about fully grown. There must be two broods of worms, as the dead chrysalids were found in some of the tubes. When about to pupate the worm spins a slight web within its tube. One larva pupated in confinement September 21. Mr. Emerton informs us that he raised the moth, which we failed to do, but the specimen was unfortunately lost.

We have found the young larvæ one-quarter grown on the white pine at Brunswick, Me., in August. They had not cut off the ends, but had merely drawn the leaves together with silken threads.

89. THE PINE LEAF MINER.

Gelechia pinifoliella Chambers.

Order LEPIDOPTERA; family TINEIDÆ.

Mining the leaves of different species of pine, a minute, brown, narrow, cylindrical larva.

“For several years the leaves of the common pitch-pine (*Pinus rigida*)

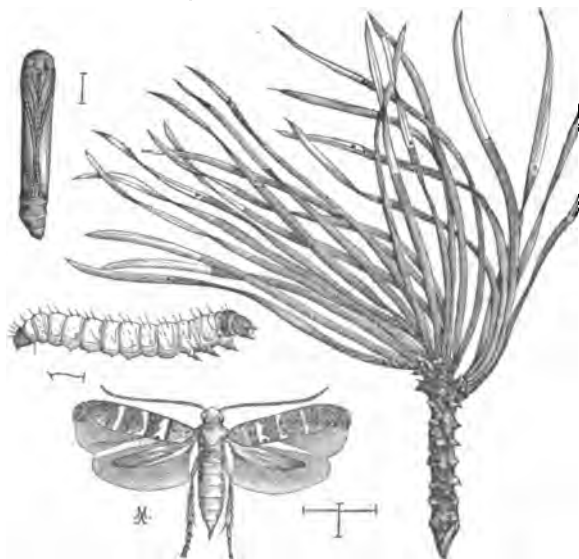


FIG. 86.—The Pine-leaf miner, larva, pupa, adult, and work.—After Comstock.

in the vicinity of Ithaca, N. Y., have been seen to be extensively mined by the larvæ of a Tineid, the life history of which we have first studied the present season. The end of the leaf, and in many cases the entire leaf above its base, becomes dead and brown, and when opened it is found to be entirely eaten out, and to contain, in the proper season, the larva or pupa of the above-mentioned insect.

“What are in all probability the eggs of this insect have been found deposited singly near the base of the leaves. They are nearly round,

flattened on the side of attachment, and slightly so on the opposite side. Their average diameter is 1.4^{mm} (.05 inch). The general color is reddish brown, differing in intensity with the stage of development. The surface of each egg is marked with numerous delicate carinæ, which meet at the center, somewhat resembling those of the cotton and boll worms figured in the article on cotton insects. We have not proof positive that these are the eggs of this leaf miner, but their size, appearance, and place of deposit seem to indicate that they are.

"The work of the growing larvæ is well shown in the plate, and also the larva itself, highly magnified. From a study of the mines, the larva appears to burrow towards the end of the leaf first. Should it arrive at the end of the leaf (and it almost invariably does) before attaining full growth, it reverses its position and mines towards the base. The hole of entrance and of future exit is apparently in all cases enlarged and the excrement pushed through, as there is but little frass to be discovered in the mine, while it can always be found in a greater or less quantity at the opening or on the leaves below. No instance has been observed in which one larva has injured more than a single leaf of *P. rigida*; but a specimen of this insect was found in Virginia upon the common scrub-pine (*P. inops*), the leaves of which are shorter and more slender than those of the pitch-pine, and, from observations made upon it, it would seem that one leaf, if small, does not afford all of the food needed by a larva.

"When found on the 1st of January this specimen was hibernating, the mouth of its burrow being covered with a thin silken curtain. Six days after, being transferred to a warm room, it was found that this curtain had been broken and the insect had left its mine. It was soon found on another leaf, and the same day formed a new burrow, where it continued to eat until January 23, at which time it had completely excavated the leaf. After this date all operations appear to have been suspended, and there were no signs of life in the burrow until March 3, when a Proctotrupid parasite issued.

"Leaves of *P. rigida* are frequently observed to be completely mined out, and nearly full-grown larvæ are occasionally found crawling about over the leaves and twigs; so it seems probable that with this species of pine also two leaves may sometimes be successively mined by the same larva.

"The full-grown larva is nearly 5^{mm} in length (.19 inch). Its color is light brown, with the head and prothoracic shield and the anal plate black. The body is clothed with a few delicate hairs. The form of the larva is shown in the figure. Upon reaching full growth the larva spins a slight covering to the mouth of the mine and retreats a short distance above it (from 10^{mm} to 15^{mm}). There, after spinning a few supporting lines of silk, it transforms to a long and slender chrysalis, light-brown at first but afterwards nearly black. When removed from the mine the pupa is very active, jerking the short end of the abdomen (which ex-

tends below the wing cases) from side to side with rapidity. The duration of the pupa state is from ten to fourteen days. The moth makes its exit from the pupa shell without disturbing the position of the latter, leaving it attached by its threads some distance up the mine, and works its own way to the entrance.

"There are certainly two broods of this insect each year, probably three, and possibly more in exceptional seasons. Of the general hibernating habits of the genus, Stainton says: "Of a few species the young larvæ live through the winter, but I believe the greater number pass the winter in the egg and pupa state." With the present species the nearly full-grown larvæ have been found during the winter, but not in great numbers. What we consider to be the egg of this species has also been found in apparently healthy condition in midwinter, and the insect, without much doubt, hibernates in both of these forms, and possibly in either of the others. The moths of the first brood issue during the entire month of June, the difference between the earlier and later ones probably depending upon the form in which they hibernate.

"As we have stated before, larvæ almost identical in appearance with those found on *Pinus rigida* in New York have been discovered on the scrub-pines (*P. inops*) around Washington. These larvæ were bred to the perfect state and proved to be the same species.

"A leaf-miner of precisely the same habits and of almost the same appearance was found the past winter in the leaves of the southern pine (*P. australis*) at Macon, Ga., a point where, owing to a sudden fall of some 400 feet in altitude, the northern and southern floras meet in a remarkable manner. Progressing southward, a careful search was made for additional specimens of this leaf-miner, but none were found except in this one locality. Assuming the identity of the two forms (they have since been bred and proved identical), it puzzled us for some time to discover how the species could have reached *P. australis*, since the southernmost limit of *P. inops* is South Carolina, and *P. rigida* is essentially northern. It was not until we discovered the same miner in leaves of the yellow pine (*P. mitis*) that we were able to solve the problem. The yellow pine is not only found north, but also extends south until at Macon, Ga., we can see it mingling with the northernmost specimens of *P. australis*.

"*The moth*.—Palpi simple; hind wings excised beneath the tips. Head white, flecked with scales of the general hue of the insect, which may be called a brownish-yellow. Palpi white; the second joint longer than the third, brownish-yellow flecked with fuscous scales on the outer side; third joint white, with a brownish-yellow annulus about its middle, and another near the tip; antennæ white, each joint crossed by a brownish band. Thorax and fore wings of the general hue above mentioned, flecked with fuscous scales. On the fore wings are three white fasciæ, placed respectively at about the basal, middle, and apical fourths of the wing length; the apex is densely dusted with fuscous on a white ground,

and the dorsal margin is sparsely flecked with brown. The fasciæ also are more or less margined with brown scales, and the third one is sometimes interrupted in the middle; and the fuscous scales which margin the first and second fasciæ (especially along the second, near the fold) form minute tufts of raised scales. Cilia grayish, with interspersed black scales, which are tipped with white. Under side of the fore wings brownish. Hind wings pale grayish with white cilia; abdomen brown above, whitish toward the apex beneath. Expanse of wings $\frac{3}{8}$ inch. (Chambers, in Comstock's Report.)

"*Egg*.—Seen from above, appears globular, with a diameter of 14^{mm} ; seen from the side, appears so compressed that its long diameter is nearly twice the length of the short. Color reddish brown. Surface marked with delicate, close, meridional carinæ, meeting at the center above and below. (Comstock.)

"*Larva*.—Length when full-grown, 4.2^{mm} ; average width, $.58^{\text{mm}}$. Sub-cylindrical; all segments except head and anal segment nearly equal in diameter, the exceptions smaller. Color yellowish brown; head, prothoracic and anal plates dark brown; mouth-parts yellowish; prothoracic shield strong, completely divided longitudinally in the middle by a moderately wide suture. (Comstock.)

"*Pupa*.—Length, 4.4^{mm} ; average width, $.71^{\text{mm}}$. Head obtusely rounded; wing-sheaths extending to sixth abdominal segment; antennal sheaths reaching nearly to end of wing-sheaths, all compactly soldered. General form very nearly cylindrical; sixth and seventh abdominal segments spreading at posterior borders; dorsal side of anal segment furnished with a cluster of from 10 to 15 delicate tentacular or hook-formed filaments. Color: when first transformed, light yellow brown, soon changing to very dark brown, almost black, on head, thorax, wings, and crural sheaths; abdomen of a lighter brown, growing still lighter towards the anus.

"*Parasites*.—A minute chalcid parasite was bred from the specimens found in *P. rigida*. From 8 to 12 of the larvæ of this parasite are usually found within the body of one of the leaf-mining larvæ. They are pale milk-white in color, and the alimentary canal blackish; they are long and slender in form. A very small Tachina fly was also bred, both from the northern and southern specimens." (Comstock in Agricultural Report for 1879.)

We have found at Brunswick, Me., young pitch-pine trees the leaves of which had been attacked by this larva; the injury was quite local, not general.

83. THE PITCH-INHABITING MIDGE.

Diplosia resinicola Osten-Sacken.

Order DIPTERA; family CECIDOMYIADÆ.

Feeding early in May, and again towards the middle of June, in companies of thirty or forty, in the pitch exuding from wounds in the bark of the pitch-pine, small slender, footless, orange larvæ, changing to two-winged midges or gall-flies late in May and the middle of June. (Comstock.)

The following account of this interesting fly is taken from Professor Comstock's Report for 1879:

In 1868, Mr. Sanborn exhibited before the Boston Society of Natural History specimens of a "Cecidomyious larva," which he had found feeding in companies of thirty or forty in the pitch exuding from wounds in the bark of *Pinus rigida*. "Whether they were the prime cause of the injury to the tree was not plainly apparent." (See Proceedings Bost. Soc. Nat. Hist., xii, 93.) In the Proceedings of the Entomological Society of Philadelphia, 1871, p. 345, Osten-Sacken records the discovery of similar larvæ in the exuding resin of *Pinus inops* at Tarrytown, N. Y. These he reared to the perfect state, and gave the species the name of *Diplosis resinicola*.

Early in May the two or three year old branches of *Pinus inops* in the vicinity of Washington were observed to be quite extensively infested by these insects, which were then in the larva state and actively feeding. They shortly turned to pupæ, and the first midge emerged May 26. On June 11 larvæ of the same species were found upon the twigs of *Pinus rigida* at Ithaca, N. Y. Pupæ were also found in the same twigs, and June 13 the first midge issued. In February, 1880, I collected specimens of similar larvæ at Orange Lake, Florida, on twigs of *Pinus taeda*, which, upon the appearance of the adults on March 1, were found to be of the same species.

Fig. 87 (from Comstock) shows well the work of this insect. The lumps of exuding resin may contain from two to thirty of the larvæ,

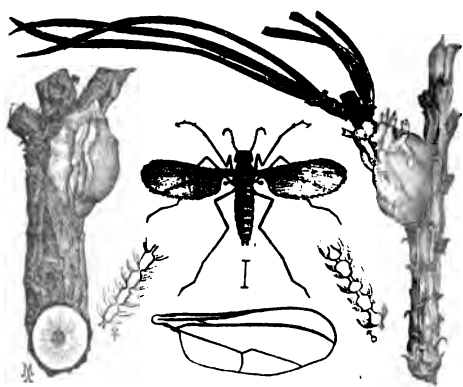


Fig. 87.—The pitch-inhabiting midge.—After Comstock.

which, when full-grown, measure on an average 6^{mm} (about one-quarter of an inch) in length. While still feeding they are pale-orange in color, but after ceasing they become of a bright orange. The spiracles of the anal segment are at the summit of two protruding tubercles, and around each is a small whorl of four fleshy papillæ. The other spiracles are small and black. The larvæ are much elongated, and are widest at the

6th segment; the under sides of segments 1 to 7 are furnished each with two transverse rows of short black or brown spines, probably for locomotive purposes. While burrowing in the bark and resin the anal tubercles are always at the surface. When, however, the larva contracts to pupate, the end of the body is drawn in, but an open channel is left so that the air has free access. When about to give out the adult, the pupa works its way to the surface of the resin and protrudes half its body, so that there is no danger of the midge becoming fastened in

the sticky gum. Dried lumps of resin, fairly bristling with protruding pupa-skins, are a common sight on trees affected by these insects. The adult insect is large, measuring 9^{mm} (.354 inch) in wing-expanse. The head is blackish, the thorax gray, and the abdomen dark red. The male antennæ are 26-jointed, with alternate single and double joints, all pedicelled; the female, 14-jointed. The main peculiarity of the adult form is in the remarkable gibbosity of the head, the eyes joining together at the summit and covering nearly the whole head. The wing-venation and other points are shown in the plate. The resin exuding from the wounds in *P. inops* is perfectly clear, and permits one to count the number of the larvæ and to watch their every motion.

Upon the loblolly pine (*P. taeda*), however, it is milky, and the presence of the insect cannot be ascertained without opening the mass.

We have as yet no data upon which to state definitely whether the eggs of the midge are laid upon the uninjured bark, and it is the work of the larvæ in the bark which causes the resin to exude, or whether it is only in resinous exudations, caused by a bruise or by the work of some other insect that the eggs are laid. In the clear lumps on *Pinus inops* the larvæ are always observed with their heads applied to the abraded bark.

Somewhat similar, though evidently distinct, larvæ were found feeding in the resin exuding from the wounds made by the larva of *Retinia comstockiana* in the twigs of *Pinus rigida*. It is probable that they may be Osten-Sacken's *Cecidomyia pinis-inopis*, but it is difficult to say positively as his description of this species is so very indefinite. (Comstock.)

We have noticed the work of this gall-fly at Providence, the cast pupa skins being found protruding from the masses of pitch June 28. We have also observed it for many years past at Brunswick, Me.

84. THE PITCH-PINE NEEDLE GALL FLY.

Diplosis pini-rigide Packard.

Shortening and deforming the needles of the pitch pine, in Maine, early in May, orange-colored larvæ, which spin a cocoon towards the end of May; the fly appearing probably in June, as the second brood of larvæ occur late in September.

* In the year 1862 or '63 I observed in an isolated young pitch pine (*Pinus rigida*) at Brunswick, Me., that many of the leaves or needles were less than half as long as usual, and much swollen at their base, as seen in the adjoining cut. These deformed needles were quite numerous on the tree, and, so far as I am aware, have not been previously noticed.

The larva is situated at the base between the inner two of the three needles, which grow from one-third to one-half of their normal length, and by the irritation set up by the worm the united base of the leaves swells into a

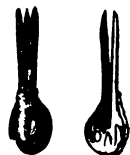


FIG. 88. — Pitch-pine needle shortened and deformed by the pitch-pine-needle gall fly. — From Packard.

* The following account and figure are taken from Hayden's Tenth Annual Report of the U. S. Geological and Geological Survey of the Territories for 1876. Washington, 1878, p. 527.

bulbous expansion about the size of a pea, or four times the original thickness of the needle, while the third or outer needle is sometimes not altered in size, but simply shortened and aborted. The bud-scales of the primary leaves are burst and hang down in shreds about the bulbous swelling of the secondary leaves or needles. The larva, which was found in the autumn of the same year (September 22), does not apparently bore into leaves, as it has no means of making its exit unless it works its way out of its prison through an oval hole between two of the leaves. It has to do so in some way, however, for when fully fed it makes its exit, ascends to the terminal buds, and pupates on one of them, exposed to the air. Sometimes there are two larvæ, one on each side of a leaf.

The cocoons are pale, oval, and covered with the pitch which exudes from the buds of the tree, and were found May 20. When the fly issues from the cocoon it creeps half way out of its cocoon, leaving its pupa-skin partially remaining, with the old pupal integument of the antennæ, wings, and legs separate.

On the 10th of June I opened the cocoon and found the pupæ of a chalcid fly, and afterwards found specimens of the adult, which, on making their exit, bore small holes through the sides of the cocoon.

The history of the species is apparently somewhat as follows: The eggs are probably laid at the base of the needles early in May, or possibly in the preceding autumn, or possibly the larva winters in the gall, though this is not probable. At any rate the worms pupate within spun silken cocoons about the middle or the third week in May, and the fly probably appears in the early part or about the middle of June, when the eggs are laid for the second brood of worms, which we have found September 22. A large percentage are destroyed by the chalcid fly.

Larva.—Deep orange in color, with the “breast-bone” retractile. The lateral swollen region of the body is well marked, convex, and the segments are short, quite convex.

Female described from life.—Antennæ 14-jointed, about half as long as the body, brown, with sparse, irregular verticils of gray hairs, the ten terminal joints twice as long as broad, and pedicellate. Clypeus and epicranium testaceous brown, the clypeus (hypostoma) having a few long gray hairs curving over and downwards. Palpi concolorous with the ends of the antennæ.

Thorax shining black, with four lines of white hairs, as in *C. pini* DeGeer; the sides including the prothorax, reddish; scutellum reddish-brown, while the trochanters are much darker, the first pair being nearly black, the two posterior pairs reddish-brown. Legs brown, paler beneath, with gray hairs, the tarsal joints darker at the articulations, covered with fine silvery hairs.

Wings rather short and broad, with scarcely any pubescence; fringe long, veins dark brown; the subcostal (first longitudinal) vein terminates at the middle of the wing (in *C. salicis* it terminates much beyond this point); the median vein terminates at or perhaps a little below the apex; it curves around rapidly, following the curve of the margin; cross-vein very minute, very oblique, almost obsolete, situated a little before the middle of the first longitudinal vein; third longitudinal vein straight, but turning down to the inner margin at nearly a right angle. The venule which, in continuation of the main vein, is bent upwards at its origin, thence goes straight to the outer edge, inclosing a triangular space. The halteres are pale flesh-colored.

Abdomen blood-red, with slight sparse hairs. The segments on the terminal half of the abdomen are edged with black, and the tip of the abdomen is blackish, while the genital armature is flesh-colored. Length, .10 inch.

This species differs decidedly from *Diplosis pini* Loew, ♀, in that the basal joints of the antennæ are not yellow, but pale brown. The clypeus (hypostoma) is reddish-brown, not reddish-yellow. The abdomen is blood-red, and the hairs are too few to give a silvery reflection; the legs do not seem whiter beneath than above; the wings are not densely pubescent as in Loew's description of *D. pini*, but are sparingly so. The cross-vein is difficult to find, and then is only seen in certain positions. It is smaller, being only a tenth of an inch long.

In its habits it seems to differ from Osten-Sacken's *Diplosis pini-inopis* in that the apparently similar pale, oval, resinous, pitchy cocoons are placed on the buds of the pine-needles, which were somewhat deformed, and could thus be easily distinguished from others not affected; as well as by the resinous pitchy exudation covering them. (This was observed May 20.) The food-plant is also different, *Diplosis pini-inopis* living on the Jersey or scrub pine (*Pinus inops*), which does not extend so far north as New England, particularly Maine.

86. THE PINE SAWFLY (*Lophyrus* sp.).

Order HYMENOPTERA; family TENTHREDINIDÆ.

Body pale yellowish-green, segments with numerous fine transverse wrinkles; head black; thoracic legs black. Observed August 17 on pitch pine at Brunswick, Me.

87. THE PHILADELPHIA CHRYSOMELA.

Chrysomela philadelphica Linnaeus.

Order COLEOPTERA; family CHRYSOMELIDÆ.

Feeding upon the leaves from May till September, a very convex broad-oval beetle about 0.30 long, of a dark bottle-green color with white wing-covers sometimes tinged with yellow and having on them numerous spots and dots of dark green with a black line on the suture widened anteriorly and a second line parallel with this on each side, the antennæ and legs rusty red. This is also common upon willows, with other species closely similar to it. (Fitch.)

88. THE PINE CHRYSOMELA.

Glyptoscelis hirtus Olivier.

Order COLEOPTERA; family CHRYSOMELIDÆ.

Feeding on the leaves in May and June, a thick cylindrical beetle resembling the Cloaked Chrysomela, No. 27, but with the pubescence much thinner than in that and the other American species of this genus. Its color is brassy, more brilliant on the under side and tinged with coppery. The male is usually 0.28 and the female 0.35 long. (Fitch.)

89. THE SARATOGA LEAF-HOPPER.

Aphrophora saratogensis Fh. var.

Order HEMIPTERA; family CERCOPIDÆ.

The larvæ form masses of froth on the leaves of the white pine in June, acquiring wings the last of July and in August in Maine. Common. (Named by Mr. Uhler.)

90. THE WHITE-NECKED PINE-BEETLE.

Dichelonycha albicollis Burmeister.

Order COLEOPTERA; family MELOLONTHIDÆ.

A small beetle half an inch long or somewhat less and resembling the Rose bug, No. 50, in its shape but with wing-covers of a shining brilliant green, becomes quite common upon pines about the middle of May, eating the leaves, and continues about a month. It may be distinguished from the several other species of the genus to which it belongs by its thorax having a more distinct but a very shallow groove along its middle. (Fitch.)

The beetle.—This species has a black head with its fore part dull pale yellow. Its thorax is black and is covered with incumbent ash gray or yellowish hairs, but not so close as to hide the ground beneath, whilst the scutel is densely coated with white hairs. The bright green wing-covers are dull pale yellow along their outer margin and also on their inner edge. They are rough from confluent punctures and show three smooth raised lines on each, running lengthwise. The legs are pale yellow with the hind feet and inner side of the hind shanks black or blackish, and the fore shanks have at their outer tips two projecting teeth with a small tubercle indicating the place of a third tooth. Its length varies from 0.40 to 0.50. (Fitch.)

91. THE PINE ANOMALA.

Anomala pinicola Melsheimer.

Order COLEOPTERA; family MELOLONTHIDÆ.

Feeding on the leaves in June and July, beetles resembling the common May beetle, No. 76, but of a much smaller size, being only 0.35 long, black, shining, their wing-covers slightly tinged with chestnut with the suture and outer margin broadly black, their antennæ pale dull yellowish, and their feet pitchy black. I only know this species from specimens from the South, but as it occurs in Pennsylvania it will probably be found also in our own State. (Fitch.)

92. THE PINE CLASTOPTERA.

Clastoptera pini Fitch.

Order HEMIPTERA; family CERCOPIDÆ.

Puncturing the leaves and sucking their juices, in July, a small shining broad oval tree-hopper 0.14 long, of a black color, its head pale yellow with a black band on its anterior margin, its thorax prettily sculptured with fine transverse lines and with a pale yellow band anteriorly, its wing-covers with a broad hyaline white margin on the outer side, interrupted with black back of the middle and having a shining black dot near the tip, its under side and legs pale yellow. (Fitch.)

93. THE TESTACEOUS CLASTOPTERA.

Clastoptera testacea Fitch.

A similar insect to the preceding, but of a pale yellow color, 0.20 long, its scutel darker tawny red or yellow, its wing-covers with a shining black dot near the tip, and often with a black dot upon each side of the breast. Appearing upon pines and also on oaks the latter part of July and in August. (Fitch.)

94. THE WHITE-PINE LEAF-HOPPER.

Bythoscopus strobi Fitch.

Order HEMIPTERA; family CERCOPIDÆ.

Puncturing the leaves and sucking their juices in May, an oblong tawny yellow or yellowish brown leaf-hopper, 0.20 long, its wing-covers inscribed with numerous black-

ish lines and dots, with a few small spots mostly on the outer margin, and crossed by three broad bluish-white bands, its legs pale yellowish with numerous black dots from which arise small spines. (Fitch.)

95. THE PINE LOUSE MIMIC.

Camaranotus confusus Hirschl.-var. *occidentalis*?

This bug closely resembles the pine Tachnus, or a dark ant, and is common running about the terminal twigs of the pine. (Named by Mr. Uhler.)

96. THE GREEN PINE TETTIGONIA.

Order HEMIPTERA; family CERCOPIDE.

Occurring in August in Maine on the pitch pine, a pretty, delicate green Tettigonia-like form, exactly of the color of the pine leaves. Pupa with some faint yellow markings.

97. THE PINE CIXIUS.

Cixius pini Fitch.

Order HEMIPTERA; family FULGORIDE.

Puncturing the leaves and sucking their juices in May and June, a brownish black four-winged fly, 0.23 long, its thorax diamond-shaped, with three elevated longitudinal lines, its fore wings transparent but not clear and glassy, stained with smoky yellow forming a few transverse spots, their veins white alternated with numerous black dots, its legs pale with the thighs brown. (Fitch.)

98. THE VERNAL DIRAPHIA.

Diraphia vernalis Fitch.

Order HEMIPTERA; family PSYLLIDE.

Upon the leaves, puncturing them and sucking their juices, a small orange yellow four-winged fly, 0.15 long, with a square flattened head concave on its upper side and with a slight impressed line along the middle of its whole length and a small notch in the middle of the anterior edge; the antennae projecting forward from the anterior corners of the head, short and thread-like, of the same length with the head, their basal joint largest and forming one-fourth part of their total length, their tips black and ending in two short fine bristles of unequal length; the fore wings thick and leathery, feebly transparent, dull pale brownish yellow; the breast and hind breast coal black, and the legs dull whitish. (Fitch.)

99. THE WHITE PINE SCHIZONEURA.

Schizoneura pinicola Thomas.

Order HEMIPTERA; family APHIDE.

Feeding on the tender shoots of the young white pines in Illinois, their presence indicated by slender snow-white silky webs, and usually covered with a clear white, cottony secretion which appears to shoot out from the body in little ribbon-like flakes; the insects pale green. (Thomas.)

100. PINE-LEAF CHERMES.

Chermes pinifolia, new species.

Order HEMIPTERA; family APHIDÆ.

Stationary upon the leaves, usually towards their ends, puncturing them and sucking their juices, a very small black fly 0.08 long to the tip of its abdomen, and 0.12 to the end of its wings, which are dusky gray, its abdomen dusky red and slightly covered with fine cottony down. (Fitch.)

The females of these insects do not extrude their eggs. Clinging closely to the leaf with their heads towards its base, they die, their distended abdomens appearing like a little bag filled with eggs. The outer skin of the abdomen soon perishes and disappears, leaving the mass of eggs adhering to the side of the leaf, but completely covered over and protected by the closed wings of the dead fly. I have met with the dead females thus adhering to the leaves the first of July, and have noticed the same insects on the leaves in full life and vigor the middle of May.

The rib vein of the fore wings runs straight to the outer margin forward of the tip, and gives off from its middle on the outer side a very oblique branch which runs to the outer margin, its tip producing a slight angular projection of the edge of the wing, and the whole space on the outer side of the rib vein beyond this branch is more opaque than the rest of the wing and of a smoky yellowish color. From its inner side the rib vein sends off three simple oblique veins, the last one of which ends in the extreme tip of the wing. The hind wings have an angular point on their outer side beyond the middle, and a longitudinal rib vein, which, forward of its middle sends off a branch almost transversely inward, its tip curved backward. The antennæ are short, thread-like, and composed of four or five small joints. It will hence be seen that this insect is a true *Chermes*—the first species of this genus that has been discovered in this country. (Fitch.)

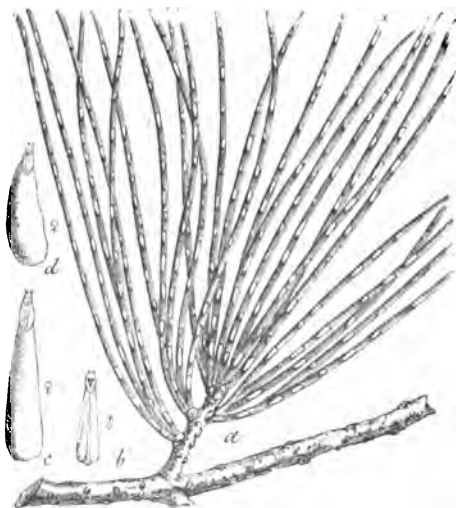


FIG. 89.—Pine-leaf scale-insect: *a*, natural size in pine leaf; *b*, male; *c*, *d*, female scale.

101. THE PINE-LEAF SCALE-INSECT.

Mytilaspis pinifolia (Fitch).

Order HEMIPTERA; family COCCIDÆ.

Fixed upon the sides of the leaves of young trees, exhasting them of their juices and causing them to turn yellow; small oblong flattish white scales, with a pale yellow spot upon their pointed end. (Fitch.)

This insect is injurious in the Western States, according to Riley, who describes and figures it in his Fifth Report. The disease to which it gives rise is sometimes called the "white malady." Riley states that it produces two broods a year in Missouri, *i. e.*, one in July and again in October. It occurs on the white pine, red pine, Bhotan pine, yellow pine, and cembra pine, and sparsely on different species of imported pines. I have also noticed it at Brunswick, Maine.

102. THE CLUB-HORNED CAPSUS.

Capsus claratus Linnaeus.

Order HEMIPTERA; family CAPSIDÆ.

In July and August, common on the leaves of this and other trees, puncturing them and subsisting on their juices, a small oblong black bug, 0.20 long, with three silvery white transverse lines on its wing-covers, the middle one longest, the middle joint of its antennæ long and towards its tip thickened and black, the last joint slender and white with its tip black, and the hanches of its legs also white. This bug is equally common here as in Europe. Its marks are so peculiar as to remove all doubts of its being one and the same species which inhabits both sides of the Atlantic.

Several other species of bugs occur upon the pine, but as they are found in greater numbers upon other kinds of vegetation, it is scarcely necessary to notice them under this head.

INSECTS INJURIOUS TO THE SPRUCE (*Abies nigra* and *alba*).

The destruction of spruce and firs in Northern New England in 1878-'81.—The forests of spruce and fir in Maine, Northern New Hampshire, and New York were, about the year 1879, destroyed by the wholesale, the coast of Maine from Portland to Eastport and Calais, on the Saint Croix river, having especially suffered. In the summer of 1880, during a hasty visit to Brunswick, Me., and the shores of Casco Bay, I noticed the great destruction that had been effected in the spruce growths on Mere point and on some of the adjacent islands of Casco Bay; but failed to detect the cause of the disease, supposing that it was too extensive to be attributed to the attacks of insects, and that some meteorological cause, such as severe winters or the attacks of some fungus, would better account for a destruction so widespread and apparently sudden.

During the last half of the summer of 1881, spent in Maine, I was enabled to make a more careful examination into the causes of the disease, and think that without much doubt it was wholly due to the attacks of various beetles, and, perhaps, in some cases, of caterpillars.

About the middle of July I went from Brunswick, Me., to the White Mountains, and observed a good many dead spruces and firs in the woods on either side of the road from Gorham, N. H., to the Halfway House upon Mount Washington. The dead spruces and firs were in nearly all cases, especially those which had evidently been cut down during the preceding winter (1880-'81), riddled by the mines or burrows of the spruce bark-borer (*Xyloterus bivittatus*).

The spruces were also infested by the common pine longicorn borer, *Monohammus confusor*, the larvæ being found to have bored the tree in all directions.

Living hemlock trees, 15 to 20 inches in diameter, were infested by large unknown longicorn borers under the bark, while the bark itself was mined in all directions by *Hadrobregmus*, whose burrows were very abundant in logs cut down during the past winter near the Glen House,

and in bark stripped from the logs; and the mines also occurred in the bark of living trees.

About the 1st of August, during a visit to Peak's Island, in Portland Harbor, large numbers, sometimes entire clumps or groups, of dead spruces were found to have been perforated by small bark-borers, not only the trunks but the larger and smaller branches, the beetles being still at work. Some of the spruces were partly killed, the upper branches retaining their leaves.

At Brunswick, Me., the dead spruce trees were found to be infested with myriads of three common borers (*Xyloterus bivittatus*, *Xyleborus cælatus*, and *Pityophthorus puberulus*), the bark being mined in every direction, the beetles occurring in the larva and pupa, as well as adult or beetle condition. Some of the trees, only partly dead, had the bark of the trunk and branches filled, so to speak, with these mischievous borers, and the results of their united labors were equivalent to barking or girdling the tree not only in one spot, but the entire tree; the deadly nature of the attacks of such a host of bark-borers mining and feeding upon the inner bark and sap-wood, the most vital part of the tree, was sufficiently obvious. The stumps of firs and spruces, as well as of white pines, which had been cut down the previous November, were swarming with these small Tomici in all stages of development, their numbers being astounding. In two hours I took 1,000 specimens of *Xyleborus cælatus* from one pine stump.

But if there had been any doubt as to the nature of the disease which carried off the spruces at Brunswick, in the woods southeast of the college grounds, in the course apparently of a single year; my visit to Merepoint demonstrated satisfactorily to my own mind that large, healthy firs, a foot in diameter, may be killed by the attacks of longicorn borers (*Monohammus confusor*), assisted by the smaller and far more numerous bark-borers, aided, perhaps, by caterpillars, with the final assistance of the common longicorn, *Rhagium lineatum*. Several living firs with only the lower branches dead were observed with the bark perforated with the holes made by the common longicorn pine-borer (see p. 152) and a *Buprestid* borer, while the boughs were tenanted by bark beetles and their young. Fir trees along the road to Harpswell from Brunswick were also observed to be perforated in the same manner; and if a dozen longicorn borers can not only injure but kill outright large, healthy sugar maples, as has been observed in Brunswick, Me. (see p. 103), there is no reason why firs from six inches to one foot in diameter should not perish from a similar cause; or if multitudes of small timber beetles or bark-borers girdle the tree from top to bottom with their mines, we do not see why this is not an efficient cause of rapid decay and death.

We next visited Harpswell Neck, and found from our own observation and by inquiry from others that a large proportion of the spruces and firs for a distance of about ten miles have died within about four years. The pleasure of driving over this picturesque road, with its

striking northern harsh, wild scenery and frequent glimpses of Casco Bay, in former years greatly enhanced by riding through bits of deep dark spruce forests, has been not a little marred by the acres and even square mile of dead spruces which border the road, stripped of their dark sea-green foliage, reduced to skeletons, and presenting a ghastly, saddening, and depressing sight. And, indeed, judging from accounts, one may travel through the spruce forests of the coast from Portland to Rockland, and farther east to New Brunswick, and meet with similar sights.

We visited late in August, in company with A. G. Tenney, esq., the farm of Mr. William Alexander, passing, before reaching the road leading to his house, an area of several acres from which the spruce growth had been cut off in consequence of their widespread destruction by insects. Mr. Alexander informed us that the spruce trees were, in his opinion, killed by small caterpillars which have been at work for five years, but which were most destructive in 1879. These caterpillars he described as being the young of a small brown moth which laid its eggs in autumn; the caterpillars hatching from them were not inch-worms, but when fully grown the body tapered towards both ends, and were about three-quarters of an inch long. They were most destructive June 20, when they are seen among the buds at the ends of the branches, where they drew the leaves together, eating the buds and not the leaves. He had also seen borers in the trees, but he thought the death of the tree should be attributed to the bud-worms, rather than to the borers. As will be seen further on, a number of caterpillars were found by us late this summer feeding upon the leaves of the spruce and fir, but the worm observed by Mr. Alexander was probably one of the leaf-rolling caterpillars, a species of the family *Tortricidæ*. A number of spruces and firs, with their leaves still on, but of a bright red, were observed scattered along the roadside; but no signs of leaf-worms or borers were observed in such trees, although the dead, leafless trees were infested with bark-borers.

That the operations of borers and bark-beetles may be aided by caterpillars in the buds as well as on the leaves seems also corroborated by observations in other localities. I was informed by C. J. Noyes, esq., of Brunswick, who is a summer resident at Mere point, that in June and the first week in July, 1878, the spruces and firs were attacked by great numbers of "little measuring worms, like the currant worm in shape," which eat the buds at the ends of the branches; since 1878 they had mostly disappeared, and this summer (1881) he had noticed only four or five.

From Harpswell Neck we traced dead spruces and firs around to West Bath, where extensive forests had been destroyed and numbers of dead hemlocks were observed, while the wood was attacked and the bark undermined and perforated by Buprestid borers, bark-borers, and the pine-weevil (*Pissodes strobi*). We have nowhere seen hemlock trees,

which are more exempt than any other coniferous trees from the attacks of insects, so much infested.

The death and destruction of spruce forests were reported to us at Rockland, Me., and at Calais, Me., the destruction having been observed by Mr. Sewall at the latter town in 1879. From these facts there is good reason to suppose that perhaps a third of the spruce and fir forests from near Portland to Calais have been destroyed by insects, most of the work of destruction having been accomplished four or five years ago, during 1878-79.

Similar damage has been done at points ten or twelve miles from the sea and in the interior of the State. The injury was especially noticed in North Topsham, near the Bowdoinham line. According to the statements of Mr. Willis, the agent of the Feldspar works in North Topsham, forwarded by Dr. C. A. Packard, of Bath, Me., the spruces were in 1879 attacked by borers and also by small caterpillars, "not measuring-worms" (probably like those observed by Mr. Alexander at Harpswell). The trees thus defoliated leaved out, becoming green again; and in 1880 and 1881 the evil seemed to be diminishing, as has been noticed at other places.

We were also informed by A. G. Tenney, esq., who in August visited the Rangeley Lakes, that he observed many dead spruces about the shores of the lakes, and from him we learned that the evil had attracted the attention of the local press in Aroostook County in Northern Maine.

Mr. Tenney also kindly handed us the following extract from the Home Farm, for July 14, 1881, published at Augusta, Me.:

Some time ago two or three articles appeared in our journal concerning the injury to the spruce timber in the northern portions of our State, caused by a minute little insect about whose history little seems to be known. Since then we have received much information concerning them from a most intelligent gentleman resident in Northern Somerset, who has been extensively engaged in lumbering for many years, and who has visited the spruce forests summer and winter, and observed the working of this very destructive insect.

The gentleman informs us that the first appearance of the insect was in 1874, and he has reason to believe it is now much on the increase, as he thinks on some townships there are now thirty dead trees from this cause, where two years ago, on adjoining townships, there was but one. The insect appears about the 1st of June, and on landings and jams of spruce; the air is full of them. They are about as large as a black fly, and are of a brownish, or dark snuff-color, the head half the size or length of the body. They are very tenacious of life, being hard and horny, and it is almost impossible to crush one between the thumb and finger. They are seen for about two or three weeks, during which time the logs and standing trees in the wood are bored full of holes about the size of a timothy straw, in which the eggs are laid, the larvæ of which appear the next summer. In felling trees in winter, thousands of these grubs drop out, from one-sixth to one-eighth of an inch long. The chickadees are very fond of them and may constantly be seen following the lumbermen and picking up their food. If the spruce are cut the first year they are attacked, they make very good lumber, but the second year, or after the sap-wood has turned black, they are quite worthless, unless the tree is two and one-half feet through, in which case the heart-wood is worth something for lumber, after the sap-wood is dead. The rapidity with which the wood of standing trees that have been punctured by these insects

decays is noticeable from the statement that in autumn, when parties are exploring, the blazing of an apparently sound tree with the axe reveals the fact that the sap-wood is thoroughly gone.

We have previously stated that Dr. Franklin B. Hough, the United States Commissioner of Forestry, visited this State last autumn and made an exploration of our northern forests, for the purpose of gathering information as to the extent of the ravages of this insect. In a letter to us, under date of May 6, 1881, he writes:

"I am well informed as to the extent of damages being done to the spruce timber in Maine and some places, and have been collecting information by circulars, correspondence, and personal inquiry for two or three years. The same mortality has been going on in the 'North Woods' of New York for five or six years, and has been made a special study under State authority. In 1868 there was published a report by the French Government upon the injuries done to spruce forests in that country, the principal part of which I have translated for use in my next report. I am under the impression that so far as the ravages of the insect are concerned, the worst is over—at least such is the opinion of lumbermen with whom I have corresponded—although the reality is sad enough. It has not been relatively greater in your State than in New York, but the losses reach to a fearfully great amount in your State on account of the great abundance of spruce in your forests. As for the remedies employed in Europe to check the ravages of insects in the spruce, they are altogether too expensive for us. We can only save what is dead, and the lumbermen are doing this as fast as possible; but notwithstanding this, a great deal will be lost. I have facts showing that like mortality has occurred long ago in other sections of the country, lasting a few years and then disappearing—as this will—perhaps being succeeded by a different growth of timber, as is observed in New York. The replies to circulars sent out last fall, indicate that the local extent of its duration will not last so long as apprehended."

Portions of the Adirondack region were, in 1876, visited by Mr. C. H. Peck, State botanist of New York, who thus reports on the evil in the Thirtieth Annual Report of the New York State Museum of Natural History for 1877 (Albany, 1879, pp. 23, 26):

While on a collecting trip in the Adirondack region, in July and August, my attention was repeatedly arrested by the extensive ravages of the spruce-destroying beetle, *Hylurgus rufipennis* Kirby, of which a partial account was given in the twenty-eighth report. The green slopes of Mount Emmons, commonly called Blue Mountain, and of several mountains to the north of it, had their beauty, and their value too, greatly impaired by the abundant intermixture of the brown tops of dead spruces. The destruction was also visible along the road between Newcomb and Long Lake, and on the mountain slopes far to the north of this road. Again, on the trail from Adirondack to Calamity Pond, there was sad evidence that the little destroyer had invaded also the forests of Essex County. From what I have seen at Lake Pleasant, in the southern part, and from information concerning the Cedar River region, in the central part of Hamilton County, there is reason to believe that much of the spruce timber of this county has already been invaded by the beetle. How much farther this destructive work has extended or will extend, it is impossible to say; but one thing is certain—it is still in progress. For the purpose of gaining more knowledge of the insect, I cut down, at South Pond, a tree that had recently been attacked by it. It was about 20 inches in diameter at the base; the foliage was still fresh and green, and there was nothing, except the perforations in the bark, to indicate that it was at all affected. The bark peeled from the trunk without much difficulty, the sap-wood was perfectly sound, and the heart-wood also, except a small portion in which there was a slight appearance of incipient decay. Longitudinal furrows, varying from 1 to 6 inches in length, were found under the bark, and each furrow was occupied by one or two beetles. The furrows are excavated from below upwards. In the short ones but one beetle was found, and but one perforation communicating with the external air.

In the longer ones two beetles (probably the two sexes) were usually found, and from two to four perforations afforded means of ingress and egress. The lowest perforation, which is the one by which the beetle first enters and commences its furrow, is often found closed or "blocked up" by the dust and *débris* thrown down by the excavator in the progress of the work. The second perforation is generally 1 or 2 inches above the first. I failed to discover whether it is made by the second beetle for the purpose of ingress or by the first beetle. The third and fourth perforations are in a nearly direct line above the other two, and are probably made from within outwardly, but for what purpose is uncertain. In one instance the two beetles were found at work making these perforations, boring through from the inner surface of the bark. In one instance the third was less than half an inch above the second, so that there would seem to be no particular necessity for it.

The eggs of the insect are deposited along both sides of the upper part of the furrow. They lie close together, almost or quite in contact with each other. When the larvæ emerge from the eggs they begin to feed upon the soft cambium and to work their way under the bark at right angles to the main furrow. They are at first so minute and work so close together that they make no distinct furrows, but seem rather to devour entirely a very thin layer of the cambium; but as they increase in size they begin gradually to form distinct furrows and to take directions more divergent from each other, and from their original course. In this way colonies from contiguous furrows at length run together, and in time the whole is surrounded by their multitudinous pathways, and the death of the tree is accomplished. Great care is taken by the parent beetles to keep their furrows separate. No instance was observed in which they ran together. In one instance the course of a furrow was changed to avoid running into the lateral furrows of a colony of larvæ just above. No furrows were found in the tree more than 10 or 12 feet from its base, thus indicating that the attacks are made upon the lower part of the trunk. The attacks are not made simultaneously. Some of the furrows in this tree were scarcely more than an inch long, and evidently had been just commenced. Others were fully excavated and contained eggs, and in others still the larvæ had hatched and commenced their work, but in none were they fully grown. In another tree, a few rods distant from the first, the attack had evidently been made earlier in the season, for the larvæ were further advanced in size and the bark on one side of the tree was well loosened, though, strange to say, the other side of the trunk was comparatively unharmed. I was unable to discover why, in this instance, the attack was limited to one side of the trunk. It is pretty evident, therefore, that the trees are attacked all along during the months of June and July, and possibly as late as August. I suspect, also, that the parent beetle, after having established a colony in one place, may emerge from her furrow to repeat the operation in another place, either in the same trunk or in a different one, but this I was not able to ascertain definitely.

A whitish fungus, *Polyporus volvatrus* Pk., scarcely larger than a hickory nut, occurs in considerable abundance on the trunks of spruces killed by this beetle. The mycelium of the fungus grows beneath the bark, and the external plant is connected with it through the perforations made by the insect. Hence this fungus becomes a conspicuous indicator of the track of the beetle and tells the tale of its destructive power.

In a subsequent report, the thirty-first, Mr. Peck thus refers to the injuries by bark borers of the balsam fir:

The wood of the balsam is of little value for lumber, owing to the small size of the tree. It contains resin and burns freely, but with a crackling noise. The smoke is very penetrating and irritating to the eyes. Near the summits of the mountains, however, it is almost the only available wood for camps and camp-fires. The bark of this tree furnishes the well-known "Canada balsam," a clear viscid resin of considerable repute in medicine and much used in mounting objects for the microscope. The resin is obtained from small vesicles or "blisters" in the bark.

It is generally more abundant in the thrifty, smooth-barked trees of low damp lands, than in the stunted growths of the mountains. Because of the value of this tree as a producer of balsam, and because of its beauty and fitness to adorn parks and pleasure grounds, it ought to be cherished and preserved. But like its companion, the spruce, it has its insect and fungoid foes. While at Summit in Schoharie County, in September, I noticed in a small grove of balsams that a dozen or more of the trees had recently been killed or were then dying. The leaves had nearly all changed their color, but for the most part yet remained on the trees.

"An investigation showed pretty conclusively that an insect was the cause of the death of the trees. A minute bark-mining beetle, both in its mature and in its larval state, was found between the bark and the wood. The beetle perforates the bark, excavates its furrow along the inner surface in a horizontal direction, and deposits its eggs along the sides of the furrow, which is less than one-sixteenth of an inch in diameter. As soon as the eggs are hatched, the larvæ begin to mine furrows of their own at right angles to the original gallery, one part eating their way upward and another downward between the bark and the wood. These larval galleries are nearly parallel to each other, and are at their beginning so minute that they are scarcely visible to the naked eye; but as the larva advances in its course it increases in size and the diameter of its furrow increases in like manner. The larvæ were found (in some instances transformed to the mature beetle) each in the larger end of its own furrow. It will be observed from the direction of the original furrow, how powerful an agent for mischief this minute beetle is. Its work is carried on in the most vital part of the tree. Three or four beetles attacking the trunk at or about the same height and on different sides of the tree, would completely and effectually girdle it and destroy its life. Even a single beetle, by extending its furrow entirely around the trunk, would accomplish the same result, but no furrows were found thus extended. The length of the original furrows appeared to be less than 4 inches. The beetle itself is scarcely more than one line long, and belongs to the genus *Tomicus*. The species is probably undescribed. In the case of the spruce-destroying beetle more workers are necessary to kill the tree because the main furrows are excavated longitudinally or parallel to the axis of the trunk, while in the case of the balsam-destroying beetle the original furrow is excavated at right angles to this axis, and therefore cuts off or destroys the vital action over a much broader space.

"The destruction of the balsams was not limited to the single grove in which it was first observed. In several places along the road between Summit and Jefferson dead and dying balsams were noticed; but the affected trees were not very numerous, and it would not be a difficult matter, with prompt and united action, to arrest the progress of the mischief. If each man, on whose land the balsams grow, would, as soon as signs of the presence of the trouble are manifest, cut the affected trees, strip off the bark and burn it, he would, by so doing, destroy the colonies of larvæ and prevent the further spread of the mischief. It is not at all probable that trees once attacked and showing signs of death can be saved, and it would be far better to cut them immediately than to allow them to remain as nurseries for these tiny marauders."

The spruce and firs in the Adirondacks, however, seem in general less affected than in Maine. Mr. John H. Sears, an observing botanist of Salem, Mass., who made a trip there late in the summer of 1881, writes me that "the spruce and other coniferous trees are remarkably healthy, noticeably so from Ticonderoga, Essex County, through Clinton County to Rouse's Point; and in Canada northward to Montreal from Lyon Mountain to Chateaugay there are large and handsome specimens over 3 feet in diameter.

Similar destruction of spruces in Maine in 1818.—From Mr. William Alexander, of Harpswell, we learned that "about eighty years ago" there was a similar destruction of the spruce growth upon the same farm (his father's) as we visited, and it was his impression that his father ac-

counted for it by the ravages of insects. The following letter from Hon. R. H. Gardiner, of Oakwoods, near Gardiner, Me., written to Mr. A. G. Tenney, editor of the Brunswick Telegraph, will corroborate the idea that the visitations of bark-beetles are in a degree periodical:

OAKWOODS, August 27, 1881.

DEAR SIR: You requested in the last number of the Telegraph information about dying spruces, for the purpose of aiding Professor Packard in his investigation of the enemies of the spruce. I can render no aid in the matter, but would remind you of a fact that may be forgotten, that in the year 1818 every spruce tree west of the Penobscot was killed by an insect. I cannot remember this, but have often heard my father speak of it. From 1833 to 1836 I was interested in the lumber business on the Kennebec and no spruce were ever seen among the rafts of logs, though spruce from the Penobscot was sold in Boston. Now, little else than spruce is cut on the upper waters of the Kennebec, but every spruce tree has grown since 1818.

I would have written direct to Professor Packard, but thought it probable the fact I speak of was known to him and I only mention it now to you in case it may have been forgotten.

Yours, very truly,

R. H. GARDINER.

Similar destruction of forests in Germany and in Scandinavia.—Wide-spread devastations in spruce forests have occurred at intervals within the past century in Europe, and this has been generally attributed by entomologists and foresters to the operations of these timber beetles or more properly bark-borers. As bearing on this point we quote from an article which appeared in Nature, for October 14, 1880:

In an article in Danish, entitled "Om Grantörken og Barkbillen," by J. B. Barth, the author, who is one of the first authorities in Norway on questions of forestry and arboriculture generally, explains his reasons for differing from the opinion commonly received, that the desiccation and ultimate death of the Norwegian spruce (*Abies excelsa*) are due to the attacks of *Tomicus typographus* (*Bostrychus typographus*), which is usually regarded as the most pernicious of all the insect enemies of the Coniferae. Herr Barth does not dispute the fact that this beetle is to be found often in large numbers on trees affected by abnormal drying up, whether still standing or cut down; but, in his opinion, although disease in the tree may be the cause, it is not the result of the presence of the *Tomicus*, which he believes to have absolutely no effect on the condition of the bark. According to this view the numerous agents employed in Germany and elsewhere to eradicate this beetle have no result but waste of labor and money, the only remedy against the drying up of the bark being a more scientific mode of clearing forests, in which the trees often perish either through overcrowding, or, more frequently, through reckless felling by which cold blasts are allowed to fall directly on the interior. Herr Barth's views are in opposition to those of the majority of the working foresters of Germany and Scandinavia, but his extensive acquaintance with home and foreign forests, his great practical experience, and his reputation as a naturalist, entitle them to all possible respect, although it is not to be supposed that his plea for the innocuousness of the *Bostrychus typographus* will be admitted without much sifting of the evidence, seeing that this insect is generally believed by German foresters to have been the cause of the destruction of the forests of the Harz Mountains, when between 1780 and 1790 two million trees died of desiccation.

The disease due to bark and timber beetles.—From the foregoing statements the reader will justly infer that the great destruction of spruce and forest trees throughout Northern New England in 1879, and four or five years following, was due to the attacks of beetles, chiefly the small

cylindrical bark-borers, belonging to the coleopterous family *Scolytidæ*; three species, *Pityophthorus puberulus*, *Xyloterus bivittatus*, and *Xyleborus cælatulus*, being the principal aggressors.

That the disease was not due to fungi has been shown by a thoroughly competent botanist, Prof. Charles H. Peck, of Albany, N. Y. That it was not due to extremely cold weather in winter is probably certain from the fact generally observed by us that spruce and fir forests, over any given area, are not universally killed, as among groves of dead spruces and firs many living perfectly healthy trees exist, while the pines and hemlocks have been unharmed. By cutting down portions of forests and thus letting in cold severe winter blasts, general and widespread destruction of entire forests may ensue, as has been shown to have been the case in France. Why pine trees should have, in general, escaped the ravages of these beetles, all of which we have found in greater or less abundance under the bark of dead pines, and especially in dead stumps, we cannot explain, except from the well-known fact that most vegetable-eating insects prefer one species of tree and retain that preference for successive generations.

Remedies.—When a growth of these trees is invaded by insects boring in or under the bark, the loosened bark should at once be stripped off and burnt. If the tree is dead it should be cut down and the bark stripped off and at once used for firewood, even if the wood is kept for future use as fuel. Trees infested by caterpillars may leave out again and gradually assume nearly their original health and vigor. But the best remedies are those of a preventive nature. In the present case, though the evil is apparently diminishing in Maine, our observations taught us that the dead firs and spruces wherever examined are teeming with thousands and even millions of small bark beetles in all stages of growth. It would therefore be wise to prevent any further spread of the evil by cutting down dead spruce and fir timber and selling it off this winter for fuel. Forests should be thoroughly cleared, and even pine stumps should be barked and the bark burned, for, as already stated (p. 175), we have taken thousands of these spruce beetles from under the bark of white-pine stumps. In fact, stumps, in the summer succeeding the falling of the tree, are a general resort for all sorts of destructive boring insects; and should it be too expensive a matter to pull up such stumps, if the bark is torn off, the naked stump will be much less frequented by noxious insects.

We will now proceed to an enumeration of the insects known to be more or less destructive to spruce and fir trees.

AFFECTING THE TRUNK.

1. THE PINE LONGICORN BORER.

Monohammus confusor Kirby.

Order COLEOPTERA; family CERAMBYCIDÆ.

This common and pernicious borer has been described and figured on pages 152–156. It occurred under the bark of dead spruces at Bruns-

wick, August 3 and 27. At the latter date three sets of the larvæ occurred—one measuring about 6^{mm}, another 9^{mm}, and a third from 16^{mm} to 20^{mm} in length. There were no fully-grown worms. It is possible that the eggs from which these came were laid in the early summer; but it is more likely that they were deposited by the female during the previous summer, as the beetle is not to be seen except from June to early September.

2. UNKNOWN BUPRESTID LARVA.

A species of *Dicerca* or *Melanophila*. (?)

Rather long and slender larvæ, with the segment next behind the head much narrower than in *Chrysobothris*, occurred in abundance under the bark of a dead spruce at Brunswick, August 27. They were nearly fully grown. The larvæ of either this or an allied species also occurred under the bark of a spruce near the Glen House, near Gorham, N. H., July 22.

3. THE LONG-LEGGED MELANOPHILA.

Melanophila longipes.

Order COLEOPTERA; family BUPRESTIDÆ.

Probably boring into the trunks, a flat-headed borer, changing to a small Buprestid beetle.

This beetle is thought by Mr. George Hunt to bore into the wood of the spruce, as he has found it on charred spruce timber under such circumstances as to lead him to believe that it depredates on this tree. Nothing is known of the habits of the larva.

The beetle.—Body deep black, immaculate; thorax with an obsolete indented line; scutellum small, subangulated; elytra finely granulated; an obtuse, obsolete, elevated line from the shoulder to the tip; tip abruptly terminated by a small spine in the center; beneath polished, slightly tinged with violaceous. Tarsi of the intermediate and posterior feet elongated, as long or longer than the tibia; first joint equal to the three following ones conjointly; fourth joint bilobate, very short. Found in Pennsylvania and the Western States. (Say.)

Leconte states that it inhabits Pennsylvania, Kansas, and the Lake Superior region; that it is very closely related to the European *M. appendiculata*, but on comparison the thorax is less rounded on the sides, which are less sinuate posteriorly. As in that species, the sculpture is very indistinct at the middle and the small carina at the basal angles nearly parallel with the margin. The elytra are more gradually narrowed behind, and the apex is rectilinearly attenuated from the suture, while in *M. appendiculata* the inner outline of the tip is concave, though not so much so as in *M. atropurpurea*. The tip of the abdomen, as in the others of this group, is slightly emarginate, with the angles acute.

4. THE WHITE-PINE WEEVIL.

Pissodes strobi Peck.

This common weevil, which is described and figured on p. 185, we have found the past season from the 10th to the 15th August, at Brunswick,

under the bark of the spruce. The cells, like those found in the pine branches, were situated under the bark of the trunk of spruces 6-12 inches in diameter, and contained the pupa or more commonly the imago. The beetles were found flying about also at this date.

5. THE RIBBED RHAGIUM.

Rhagium lineatum Olivier.

Already described on p. 162, this insect occurred in the larva state in abundance under the bark of spruce stumps and standing trees, loosening the bark, but never doing any mischief as far as we are aware to the living tree. Small larvæ, only 4 or 5^{mm} in length, occurred in spruce stumps August 25, while others were 14^{mm} long. Fully grown ones occurred in neighboring pine stumps, and one after having been kept in confinement until the last of September went into the pupa state. The eggs from which the smaller ones hatched were probably laid in the early summer; the trees containing these grubs were cut down in November, 1880, so that it is not probable that the larva lives more than one year.

6. THE UNARMED SPRUCE BARK-BORER.

Xyloterus bivittatus Kirby.

Order COLEOPTERA; family SCOLYTIDÆ.

This is the most destructive pest of the spruce, the beetle most concerned in the ravages of spruce forests in northern New England from 1878 to 1881. We first observed it July 22, 1881, in spruce stumps near the Glen House, in the White Mountains, N. H., the tree having evidently been cut down within a few months; the beetles were very abundant, and though there were no perforations in the bark, there were small holes between the bark and the wood on the top of the stump, the beetles having availed themselves of the shrinkage of the bark due to drying of the wood, to effect an entrance between it and the wood itself; here they were congregated in abundance and were apparently engaged in making the primary galleries of their mines and laying their eggs. It was also found under the bark of dead standing or fallen spruces. Afterwards (July 27) this bark-borer was found in abundance, many larvæ, a few pupæ, and beetles in great numbers, under the bark of partly living and dead spruces at Brunswick. The burrows made were small and irregular, slightly larger than the size of the beetle, and were much like those made by *Xyleborus cætatus*, with which it was commonly associated. It was also found at Merepoint. The trees at Brunswick teemed with them, and many fewer beetles than those observed would suffice to completely girdle and kill the tree.

This beetle has its insect enemy; we observed a green chalcid fly under the bark, July 27, and a month later, August 25, chalcid larvæ nearly fully grown were found under the bark so near the larvæ of this

beetle, that we feel justified in supposing that it must have been feeding on them.

In the genus *Xyloterus*, according to Leconte (Rhyncophora, p. 357), the club of the antennæ is oval, compressed, and solid, without articulations; the shining corneous part extends forwards in a narrow band as far as the middle, except in *X. politus*, where it is entirely basal, and the club is indistinctly divided by one round suture; the rest of the surface is opaque, finely pubescent, and sensitive. The funicle is composed of two parts, as in the two preceding genera; the first joint is large, and stout as usual, the remaining part is about equal in length, forming a pedicel to the club, and is divided by two not well marked transverse sutures, thus causing the funicle to be 4-jointed. The eyes are moderately finely granulated and completely divided. The head is large, exerted, and in the ♂ is deeply concave. The prothorax is broader than long, and strongly asperate in front in the ♀, less in the ♂. The tibiæ are dilated, finely serrate on the outer edge, rounded at tip, and very feebly mucronate at the inner angle; the tarsi have the joints 1-3 rather stout, nearly equal in length; fourth very small, fifth slender, as long as the second and third united, with simple divergent claws. The hairs are not serrate or verticillate, as in *Pityophthorus*, but slender and smooth.

The four species in our fauna are easily recognized:

- Elytra with well defined striæ of punctures, interspaces nearly smooth..... 2.
 Elytra with ill-defined distant rows of punctures, interspaces equally strongly punctured, pubescence erect, abundant..... 4, *politus*.
 Prothorax finely and sparsely punctured at the sides towards the base..... 1, *retusus*.
 Prothorax finely but less sparsely punctured at the sides towards the base. 2, *bivittatus*.
 Prothorax scabrous and granulate behind the middle..... 3, *scabricollis*.
X. bivittatus Mannh., Bull. Mosc. 1858, 236; *Apate biv.*, Kirby, Faun-Bor. Am. IV, 192, pl. 8, fig. 5; *Bostrichus cavifrons* Mannh., Bull. Mosc. 1843, 297 (♂); *ibid*, 1852, 359; *Xyloterus cav.*, Mannh., *ibid*, 1852, 385.

Maine, Canada, Alaska, Vancouver's Island; length 3-3.3mm; .12-13 inch. Varies greatly in color. Usually the front part of the prothorax, the suture and the margin of the elytra are black; sometimes only a short, pale stripe is seen on each elytron. (Identified by Dr. Horn.)

7. THE SPINED SPRUCE BARK-BORER.

Xyleborus caviatus Zimmerman.

Order COLEOPTERA; family SCOLYTIDÆ.

As the foregoing species has smoothed unarmed elytra, we have named it the "unarmed spruce bark-borer," while the present species, which is also destructive to spruce, though abundant in pine trees (p. 175), being gouge-shaped at the end of the body with two prominent teeth on each side at the end, we would name "the spined spruce bark-borer." Its habits and mines are apparently like those of the foregoing species, but the mines are a little larger, as is the beetle itself. We noticed the beetles in great

numbers with several pupæ under the bark of the spruce at Brunswick, August 22, and under another tree, observed August 27, there were many pupæ, and numerous pale beetles which had only recently cast off their pupal skins. There were all stages between very pale beetles and the dark, black-brown fully mature beetles; some with a short, broad dark stripe on each wing-cover; this might be thought at first sight a different species, and indeed it is probable that from variations in age and size, too many species of these bark-borers have been described.

Leconte states that the genus *Xyleborus* has "the body stout, cylindrical; declivity of elytra oblique, scarcely flattened; funicle of antennæ with four distinct joints; tibiæ finely serrate on the distal half of their length and rounded at tip." *X. calatus* ranges from Canada to Texas and California. In this species "the declivities of the elytra at the end of the body are with two prominent tubercles, and some smaller marginal ones; elytra strongly punctured in rows; interspaces with rows of distant punctures." (Identified by Dr. Horn.)

8. THE LEAST SPRUCE BARK-BORER.

Crypturgus atomus Leconte.

Order COLEOPTERA; family SCOLYTIDÆ.

This minute bark-borer, though often occurring in white pine bark, must not be confounded with *Pityophthorus puberulus* of the white pine (p. 172), as its burrow is very different. The present species is $1\frac{1}{3}$ mm long, and $\frac{2}{3}$ mm in diameter. The mine consists of a short sinuous primary gallery about $\frac{1}{2}$ inch long, which gives off at intervals about ten short secondary galleries from each side, but they are not made in the same plane, next to the sap-wood as in *P. puberulus*, but penetrate only the bark itself in all directions, so that no regular pattern is formed. The beetle is extremely numerous, a great many dense mines being situated within a square inch of surface. They were observed in great profusion in the larva, pupa, and beetle states at Brunswick, Me., during August; in standing dead trees as well as spruce stumps; also in white pine stumps. Many of our observations on this and the foregoing species, as well as the Rhagium, were made by the side of Maquoit street, Brunswick, on land from which timber was felled, as we were informed, in November, 1880, so that the period during which the insects had been at work was known quite exactly.

This species has been kindly identified for us by Dr. John L. Leconte, of Philadelphia, who has also prepared the following description, which is much more complete than the original description in the Transactions of the American Entomological Society.

The beetle.—Slender, dark piceous, shining, prothorax distinctly longer than wide, sparsely and coarsely punctured; elytra very finely not densely pubescent, striæ composed of shallow punctures, interspaces as well as the striæ without distinct punctulation. Length 1 mm +. Head with a broad short beak, slightly convex, finely not densely punctulate. Prothorax distinctly longer than wide, slightly rounded on the

sides, gradually narrowed from the middle to the tip; disc transversely convex, not polished, but very imperceptibly granulate, sparsely and strongly punctured. Elytra cylindrical, not wider than the prothorax, convexly declivous behind; sparsely clothed with very short and fine yellowish pubescence; striae composed of rather large shallow punctures, interspaces not narrower than the striae, almost imperceptibly punctulate. Beneath nearly smooth, sides of metasternum with a row of punctures, sides of ventral segments feebly punctured. Legs piceous, front tibiae with 5 distinct acute teeth on the outer edge, which is also sparsely fringed with long yellowish hairs, with a fine apical spine at inner angle; tarsi yellow, narrow, third joint not dilated. Antennae with the scape long, the first joint of the funicle large, rounded, second indistinct, closely connected with the club, which is large, oval, not pointed, solid, polished, and corneous except along the apical margin, where there is a spongy sensitive band.

9. THE PINE TIMBER BEETLE.

Pityophthorus materarius (Fitch).

This bark-borer has been noticed on p. 173. We found numbers of them at Brunswick in August, 1881, which were identified as such by Dr. Horn, under the bark of a spruce, which had been cut down the preceding November; a few larvæ occurred with these.

10. *Hylurgops pinifex* Fitch.

This species, noticed on p. 177 as occurring in pine stumps, was also found mining under the bark of spruce stumps of trees felled in November, 1880. The track was made at the beginning of the roots, and is slightly sinuous, two or three inches long; 3^{mm} wide, while the diameter of the hole for the exit of the beetle is 2½–3^{mm} in diameter.

11. *Cupes concolor* Westwood.

Order COLEOPTERA; family CUPESIDÆ.

This beetle has been found by Mr. G. Hunt upon or among spruce boards in a tannery in Northern New York; hence he thinks it may be a spruce insect.

12. THE PINE NEPHOPTERYX.

Pinipestis Zimmermanni Grote.

This is said by Mr. Zimmermann to be destructive to young spruces in New York. (Can. Ent., xii, 59. See p. 182.)

AFFECTING THE LEAVES.

13. THE CHECKERED PINE MEASURING WORM.

Feeding on the leaves in August and early September in Maine, a geometrid caterpillar with the body very slender, gradually increasing in width towards the anal prolegs.

Head very small, much narrower than the body, deeply indented on the vertex, each side angular above. General color that of the bark of the spruce twigs, checkered with black and gray, with a lateral black

flattened and broad tubercle on each segment. This is a very pretty wood-colored caterpillar, congeneric with No. 9 on the fir. They vary in intensity of color, some being much darker than others; the small ones paler. Length, 12^{mm}.

14. THE LIVID GREEN SPRUCE MEASURING-WORM.

Feeding on the leaves late in August in Maine, a peculiar very smooth slender larva; the head smooth, as wide as the body; the latter of uniform width. Above livid greenish, with a faint purplish tint. Lateral ridge pale green; body beneath pale greenish. Length 12^{mm}.

15. THE RED AND YELLOW-STRIPED SPRUCE MEASURING-WORM.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Feeding on the leaves late in August, a small geometrid caterpillar, with the body flattened, reddish above, with a linear, very narrow delicate red dorsal line; lateral ridge straw-yellow. Anal plate short and broad, with two conical spines projecting behind it. Body beneath whitish yellow.

16. THE SPRUCE TWIG-MIMICKER.

Order LEPIDOPTERA; family PHALÆNIDÆ.

This interesting geometrid caterpillar is over an inch (30^{mm}) long, and closely mimics the dry twigs of the spruce and fir. The head is slightly wider than the body; rounded, the vertex on each side rather full. The body with four small, high, rounded dark tubercles on each segment; and low down on the side of each segment is a group of four irregular dark tubercles. Just behind the prothoracic stigmata is a dorsal, high, prominent transverse rough ridge. Supra-anal plate rounded at the apex, with four setiferous, slender, rounded tubercles, arranged nearly in a square, and projecting backward from the apex; while below the two anal tubercles are large, full, and rounded at the end. General color lilac-ash; head variously striped and mottled, and the body irregularly mottled and spotted with ash and black. Segments transversely wrinkled; the lateral ridge moderately prominent. In the young, two-thirds grown, the body is darker, and there is a row of irregular conspicuous white spots on the side of the body. It is distinguished from No. 9 on the fir by the rounded, less angular head, and by having four instead of two tubercles, but belongs to the same genus. It is also different from No. 9 on the fir in not having a lateral yellow line.

17. THE CONE-HEADED SPRUCE CATERPILLAR.

A noctuid or sphinx? larva, feeding late in August in Maine on the spruce, with ten abdominal feet. Head very large, vertex high, ending in a large cone. Supra-anal plate large, long, triangular, ending in two blunt conical tubercles. Head pale green, tipped with red on the point of the vertex, from which two faint white bands pass down by the eyes. Clypeus and labrum honey-yellow, black on the sides. Two dorsal and two lateral continuous linear white lines. A broken substigmatal broad snow-white line. Thoracic feet pale green; abdominal feet tipped with red. Moulded August 30. Length 20^{mm}.

18. THE FIR HARLEQUIN CATERPILLAR.

This caterpillar, more commonly found on the fir, is described on p. 239.

19. *Eacles imperialis* Hübner.

This caterpillar is reported by Mr. Hulst to feed on the spruce. (Bulletin Brooklyn Ent. Soc., ii, 77.)

20. THE SPRUCE SAW-FLY.

Lophyrus abietis Harris!

Order HYMENOPTERA; family TENTHREDINIDÆ.

Occurring infrequently and not gregariously in Maine late in August on the spruce, a false-caterpillar; the body long, broader than the head; pale pea-green, the color of the leaves. Head smooth, concolorous with the body, with a dark patch extending upward behind each eye. Body with a dorsal dark green stripe, bordered on each side with whitish glaucous green. Along the body a lateral conspicuous broad white stripe, the stripe much scalloped below. Body beneath and prolegs uniformly green. Thoracic legs pale honey yellow, except at base. Length 17mm.

No black spots on the body; though Harris says the larva of *Lophyrus abietis* is like that of Abbot's white pine saw-fly. (See p. 197.)

21. THE SPRUCE BUD-LOUSE.

Adelges abieticolens Thomas.

Order HEMIPTERA; family APHIDÆ.

Deforming the terminal shoots of the spruce, producing large swellings which would be readily mistaken for the cones of the same tree.

We take the following account and illustration from our Guide to the Study of Insects: "The genus *Adelges* was proposed by Vallot for certain broad, flattened plant-lice which attack coniferous trees, often raising swellings on twigs like pine and spruce cones. The antennæ

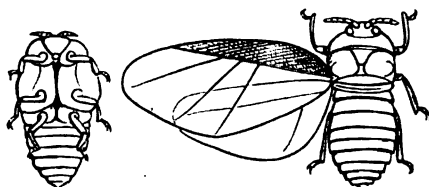


FIG. 90.—The spruce louse.—From Packard.

are short, 5-jointed and slender; there are three straight veinlets arising from the main subcostal vein and directed outwards, and there are no honey tubes; otherwise these insects closely resemble the *Aphides*. A species

closely related to the European *Adelges* (Chermes) *coccineus* of Ratzeburg, and the *A. strobilobius* of Kaltenbach, which have similar habits, we have found in abundance on the spruce in Maine, where it produces swellings at the ends of the twigs, resembling in size and form the cones of the same tree. We would add that each leaf-bud is enlarged, having an *Adelges* under it. As those nearest the base mature first, and leave their domicile the deformed leaf-bud stands out from the axis of the shoot, thus giving the cone-like appearance to the end of the shoot." This has since been described by Prof. Cyrus Thomas in his Third Report on the Injurious Insects of Illinois, p. 156.

22. THE EUROPEAN SPRUCE BUD-LOUSE.

Adelges abietis Linn.

We observed this species in considerable numbers on the Norway spruces on the grounds of the Peabody Academy of Science at Salem, in August 1881. The deformation produced in the terminal buds and twigs were like those figured in Ratzeburg's *Die Waldverderbniss*, Bd. i, pl. 28, figs. 1, 2.

23. SPRUCE-TREE PLANT-LOUSE.

Lachnus abietis Fitch.

Occurring on *Abies nigra*; the wingless females pubescent, broadly oval, blackish, clouded with brown, with a faint ashy stripe on the back; under side mealy, with a black spot near the tip; antennæ dull white, with a black ring at the tip of each joint. Length to the tip of the abdomen 0.15 inch. (Fitch.)

It is probably this species which we have found in abundance on the terminal branches of spruces at Brunswick, Me., in July and August.

24. THE SPRUCE-TREE LEAF-HOPPER.

Athyas abietis Fitch.

Order HEMIPTERA; family TETTIGONIIDÆ.

Puncturing their leaves and extracting their juices the latter part of May and during the month of June, an oblong black shining leaf-hopper 0.20 long, tapering posteriorly, and broadest across the base of the thorax, with a light-yellow head, having the mouth black and also two bands upon the crown, the ends of which are often united, and commonly with a white streak on the middle of the inner edge of the wing-covers, its legs being pale yellowish varied more or less with black.

"I first met with several specimens of this insect eleven years since, upon the black spruce and fir balsam, on the summit of the Green Mountains, in an excursion hither with that martyr of science, the late Prof. C. B. Adams. Since then I have repeatedly captured this same insect upon birch trees, distant from any spruces, and it is possible it might have been accidentally present on these latter trees in the instance first mentioned, there being numerous birch trees in the same vicinity." (Fitch.)

INSECTS INJURIOUS TO THE FIR TREE (*Abies balsamea*).

AFFECTING THE TRUNK.

1. THE PINE LONGICORN BORER.

Monohammus confusor Kirby.

Fully grown larvæ, very large and long, and evidently ready to pupate, occurred under the bark of a dead fir near the Glen House, White Mountains, July 22. A fir tree was evidently killed by these borers at Merepoint, Brunswick, Me., as from the freshly cut stump a fully grown

dead larva and beetle were taken from the holes, several of which were in the tree. The holes were round and 7^{mm} in diameter. Other trees were observed here and also on the Harpswell road with large round holes in the bark, evidently the work of this borer.

2. *Xyloterus bivittatus* (Kirby).

This beetle occurred, though not commonly, under the bark of the fir near the Glen House, July 22.

3. *Xyleborus cælatus* Zimmermann.

This beetle occurred in abundance in a fir stump, with the larvæ, August 27, at Brunswick.

4. *Crypturgus atomus* Leconte.

This minute species occurred frequently under the bark of a fir stump at Brunswick late in August.

5. THE WHITE PINE WEEVIL.

Pissodes strobi Peck.

This weevil, with the larva and pupa, was found under the bark of a fir tree on the Mount Washington carriage road, near the Glen House, July 22.

6. *Rhagium lineatum*.

Larvæ of this beetle, one-half grown, occurred August 27, at Brunswick, in a fir stump.

AFFECTING THE LEAVES.

7. THE FIR-TREE SAW-FLY.

Lophyrus abietis Harris.

Order HYMENOPTERA; family TENTHREDINIDÆ.

This pest of the fir which also infests pines has been described on page 197.

The specimens I found of this species, the females of which I raised from the larva and submitted to Mr. E. Norton for identification, had larvæ, of which the following description is taken from my notes. Much like that on the cedar and juniper, but darker green, with a black head and thoracic feet. Median dorsal stripe pale instead of dusky, and beside a pale subdorsal stripe, with a whitish green, lateral firm stripe. Beneath paler green than above. Of the same size. It spun a light silk cocoon August 23. The imago was found dead in the breeding box September 14, 1881, and must have left the cocoon during the first week in September. The antennæ are black, serrated. Body dull horn-yellow; abdomen a little paler, more amber colored; legs concolorous with the body. Wings smoky, with black veins. Length 7^{mm}. Cocoon regularly oval-cylindrical; of a pale silken brown; length 8^{mm}.

8. THE FIR NEEDLE INCH-WORM.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Feeding in August on the leaves of the fir and very closely mimicing the reddish partly dead leaves or needles; a measuring or inch worm, with the body flattened from above downward and tapering at both ends, thus closely approximating the form of a fir leaf. Head small, narrower than the body; smooth, pale, mottled and spotted with reddish. Body reddish, covered with fine whitish papillæ; a faint blackish, somewhat broken narrow dorsal line; a fine pale whitish subdorsal line. Lateral line yellowish in partly grown caterpillars, obsolete in larger ones, becoming distinct on the sides of the not large, sharply acute supra-anal plate; two large acute spines below the plate. Body beneath of a peculiar glaucous greenish white, with a median reddish line. Thoracic and abdominal legs dull livid reddish. Length 20^{mm}. Observed not unfrequently at Brunswick, Me., late in August; also found feeding at Brunswick on the low-bush common juniper (*Juniperus communis*) August 26-29, 1881.

This is one of the most remarkable cases of mimicry yet noticed among those feeding on coniferous trees. Often on beating them into an umbrella, which I used in collecting caterpillars, have I hesitated to pick them up, waiting to see whether or not they were simply dead fir leaves; in some cases the caterpillars themselves answering the question by walking off at their peculiar measuring gait.

The caterpillar changed to a chrysalis August 25, the pupa, at first greenish, became pale mahogany brown. Length 6^{mm}.

9. THE ANGULAR-HEADED, MARBLED FIR INCH-WORM.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Feeding on the leaves in Maine, late in August, a very slender inch-worm; the body tuberculated, blackish brown. Head angular; the vertex angulated above on each side. Body with five pairs of well marked small prominent tubercles; sutures between the segments not well marked, so that it is difficult to tell on which segment the tubercles are situated. Body wood-colored, the shade of the bark of the tree, mottled with black-brown, reddish gray and gray markings. Head marbled or mottled like the body, with a whitish line along the top of each side, and continued along the prothoracic segment, and in the form of two broken white faint lines along the sides towards the end of the body. Anal legs much larger than the other abdominal legs. Length about 20^{mm}.

This caterpillar is not specially mimetic, though it is probably protected from the search of birds by its general resemblance to a dry fir twig. It may be recognized by its angular head, dark marbled body, colored like the bark of the branches on which it rests, and by the five pair of sharp, prominent small tubercles. It closely resembles in coloration the noctuid caterpillar (No. 14) on the same tree. It may be found to be identical with No. 16 on the spruce.

10. THE TEN-LINED PINE INCH-WORM.

Feeding on the leaves of the fir, hemlock, and spruce, an inch-worm with body very slender, with minute prominent tubercles, and a large, full, rounded head; the latter deeply divided in the middle, and much wider than the body. The general color a flesh tint, with 8-10 blackish-brown lines on top of the body. Head reddish, mottled

with dark brown. On the side of nearly each segment a pair of dark acute tubercles and below the bright straw-yellow lateral ridge (the line is broken in fully grown larvæ) is a black irregular flattened broad eminence. Supra-anal plate large, projecting far behind and, like the pair of anal legs, flesh red. Body beneath deep flesh-colored, with dark linear stripes. Length of body 20^{mm}.

This caterpillar, which may be recognized by its slender body, with 8-10 dark lines, the broken lateral straw-yellow line, and the larger rounded deeply incised head, is common not only on the fir, but also on the spruce and hemlock late in August and early in September in Maine. In fully grown caterpillars on each segment of the body are two high rounded subdorsal and two larger lateral tubercles, which are reddish flesh-colored tipped with black, and there are two rounded supra-anal tubercles. This caterpillar is infested by a *Microgaster*, a single one of these small ichneumon larvæ issuing from the body and spinning a cocoon during the last week of August. The same caterpillar is described under Pine insects No. 78, p. 206.

11. THE RED-HEADED GREEN INCH-WORM.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Feeding on the leaves in July and August in Maine, a green inch-worm, whose body is of the width and length of a fir leaf. Body rather thick and uniformly so. Head green in the middle, bright reddish on the sides, mottled with red-brown, and with two converging, narrow oval, pale red spots in front just below the vertex; clypeus tinged with red. Body pale green; a broad dorsal whitish green band of the same color as the under side of a fir leaf, and containing a median darker dorsal stripe. The band is whitish on the edges, next below which are two very narrow dark brown hair lines. A whitish line below the stigmata, and still farther below a narrow whitish line, and two parallel dark subventral lines. The thoracic legs reddish; the abdominal legs green. It also lives on the pitch pine and will feed on the white pine.

12. THE 14-FLAPPED FIR INCH-WORM.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Feeding on the leaves of the fir late in August in Maine, a geometric caterpillar bearing a striking resemblance to the small reddish twigs of the fir with the leaf-scars. Body dull brick-red, with seven pairs of broad flat flaps on each side, those in the middle of the body being the largest. Head angular on the sides, deeply incised; when at rest retracted partly under the projecting prothoracic segment. The last segment with a large triangular thick lateral flap. Two dorsal dull yellowish sinuous lines, separated by a narrow median reddish line. Body beneath with dull obscure sinuous somewhat broken coarse yellowish lines. On the last segment are two high sharp tubercles. Supra anal plate rounded. Body roughly granulated. A light dull whitish yellow lateral stripe, extending down on the anal legs. Length 15^{mm}. Perhaps a species of *Aplodes* or allied genus.

13. A NOCTUID LARVA.

Order LEPIDOPTERA; family NOCTUIDÆ.

Feeding on the leaves in August in Maine, a cylindrical noctuid larva with 10 pairs of abdominal legs. Head of moderate size, as wide as the prothorax; body thicker just in front of the middle. Segments of the body rather convex; prevailing color pale horn-

brown, mottled with yellowish or reddish brown; with four black rounded button-like tubercles arranged in a trapezoid on the top of each segment. Length 18^{mm}.

14. THE FIR HARLEQUIN CATERPILLAR.

Order LEPIDOPTERA; family NOCTUIDÆ.

Late in summer in Maine, feeding on the leaves of the fir and spruce, a singularly humped and spotted caterpillar, with four pairs of abdominal legs. Body short, much swollen on the second ring behind the head and the first abdominal segment, and humped between the last and the penultimate abdominal legs. Head very small, striped with black. Ground tint a wood color mottled with gray and black, with scattered white spots. An irregular lilac dorsal band. A pair of conspicuous white dots on the hump behind the head, and another pair on the posterior hump. Body very much variegated in tints and it is difficult to describe briefly all the details of the markings. Length 12–14^{mm}. This singular caterpillar is not infrequently beaten off from the fir and spruce. It was observed late in August.

15. THE WHITE-LINED CATERPILLAR.

Order LEPIDOPTERA; family NOCTUIDÆ.

Feeding on the leaves of the fir in August in Maine, a larva of the usual Noctuid form. Head nearly as wide as the body, smooth; body rather thick, smooth, pale pea green. A dorsal somewhat broken snow-white line, and two wider subdorsal ones. A broken bright red lateral line, edged below with white and yellowish. Ends of all the legs reddish. Length 22^{mm}.

16. THE TUSSOCK MOTH.

Orgyia leucostigma Smith-Abbott.

Order LEPIDOPTERA; family BOMBYCIDÆ.

Feeding on the leaves of the fir in July and August in Maine, a hairy caterpillar with two black pencils of hairs in front; one median, one behind; four medio-dorsal short thick yellow tufts, succeeded by three dorsal coral-red tubercles on the back.

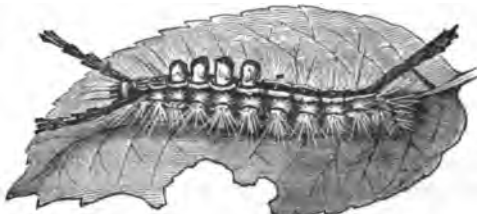


FIG. 91. The tussock caterpillar. Nat size.—After Riley.



FIG. 92.—The tussock moth; a, female; e, male; c, female pupa; d, male pupa; b, freshly-hatched larva. Nat. size.—After Riley.

17. THE PINE LEAF MINER.

Gelechia pinifoliella Chambers.

The leaves of the fir were found at Brunswick, Me., to be affected by this miner much as in the pitch pine (p. 208), the terminal third of the leaf being paler than the rest. A dead pupa skin was found July 15.

18. THE FIR SCALE INSECT.

Lecanium.

On the upper side of a fir leaf a single specimen of *Lecanium* was found at Brunswick, which was low, flat, broad oval, blackish, almost as broad as the leaf.

19. THE PINE MITE.

Order ARACHNIDA; suborder ACARINA.

Quite prevalent on the fir, working at the base of the leaves at the ends of the twigs, in summer and early autumn, in Maine; little dark mites, with rounded bodies, and quite active in their movements, causing the leaves of the fir especially to curl up, and to show the light under side. These little active mites spin a slight web in the axils at the end of the shoots. They are dark brown, with a yellowish head and thoracic region, while the legs and under side are of the same yellowish tint. They were observed from the middle of July until the first of September at Brunswick, Me., and occurred on the white pine as well as the fir trees.

INSECTS INJURIOUS TO THE HEMLOCK (*Abies canadensis*).

1. THE CANADIAN LEPTURA.

Leptura canadensis Fabricius.

Order COLEOPTERA; family CERAMBYCIDÆ.

Probably mining the trunk of the hemlock, a longicorn larva changing to a rather large handsome black beetle, with the black wing-cases deep red at the base, and antennæ broadly ringed with reddish.

Dr. Fitch refers to the remarkable immunity of the hemlock from the attack of insects, and our experience of twenty years corroborates his opinion. He states, however, that the porter *Hylotrupes* (*H. bajulus* Linn.) is reported to sometimes attack this fortunate tree, and that the larvæ of the pine *Eacles imperialis* is said to occasionally feed on it, as well as a bug.

Mr. George Hunt, of Providence, tells me that he has found the pupa of *Leptura canadensis* in the stumps of the hemlock in July in the Adirondacks, New York. The beetle is rather a large one and is black, the surface coarsely and densely punctured. It may readily be identified by the base of the wing-covers being deep red, while the antennæ are broadly ringed with paler red, the joints in the middle being alternately red and black. It is three-quarters of an inch in length, and is

a common beetle. A few other borers are mentioned below which we have found the past summer in dead hemlock trees.

2. *A large longicorn borer.*

Order COLEOPTERA; family CERAMBYCIDÆ.

Mining under and loosening the bark of fallen hemlock logs near the Glen House, White Mountains, N. H., a large longicorn borer with the general appearance of *Monohammus*, but belonging to a different genus. Length of the different specimens from 7 to 17^{mm}.

3. *A short, thick longicorn borer.*

Order COLEOPTERA; family CERAMBYCIDÆ.

Found under the bark of dead hemlocks at Bath, Me., July 30, a short, thick unknown longicorn borer.

4. *A Buprestid borer.*

Order COLEOPTERA; family CERAMBYCIDÆ.

Found under the bark of dead hemlocks at Bath, Me., July 30, a Buprestid larva of different sizes, perhaps a species of *Dicerca*.

5. THE WHITE PINE WEEVIL.

Pissodes strobi Peck.

This weevil and its cells were found in hemlocks among a number of small standing dead spruces, which had, like them, been killed by the attacks of longicorn borers, and by the following species of bark-borer:

6. THE LEAST SPRUCE BARK-BORER.

Crypturgus atomus Leconte.

This minute bark-borer was observed in considerable numbers in standing dead hemlocks at Bath, Me., July 30.

7. THE HEMLOCK BARK-BORER.

Hadrobregmus foveatus (Kirby).

Order COLEOPTERA; family PTINIDÆ.

The bark of hemlock trees and of hemlock logs, as well as the separated bark piled up by the roadside near the Glen House, in the White Mountains, last summer, was found to be perforated in all directions by this beetle, which has been obligingly identified by Dr. G. H. Horn, of Philadelphia. Not only the bark of dead trees, but that of healthy large trees had harbored great numbers of these beetles. They, however, had disappeared from the holes at the date (July 22) I was at the White Mountains, and but a single dead specimen was found. Similar mines were found in a hemlock at Brunswick, Me.

8. THE BROWN PRIONUS BEETLE.

Orthosoma brunneum (Forster.)

Order COLEOPTERA; family CERAMBYCIDÆ.

Mr. F. G. Schaupp writes me as follows concerning this beetle, which is not harmful to the tree, attacking it usually when in the last stages

of decay: "In a hemlock tree I found, July 20, in New York, hundreds of the larvæ of all sizes from 5-50^{mm} in length; the wood being exceedingly hard and tough, but although the new developed imagines (soft) were very abundant, and although I found some mouldy dead pupæ, I could not find a live pupa."

AFFECTING THE LEAVES.

9. THE HEMLOCK INCH-WORM.

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding on the leaves late in August in Maine, a slender-bodied measuring inch-worm of the general color of the terminal twigs, and not quite so wide as a hemlock leaf. Head not so wide as the body, with a moderately deeply impressed median line; pale flesh-colored, mottled, with pale reddish brown spots, and with long brown hairs. Body mostly greenish yellow, the tints pale and delicate. A dorsal row of diffuse elongated spots, extending backward from the transverse blackish stripes on the sutures between the segments. On each of the three thoracic segments is a transverse row of black warts and hairs, situated on the hinder edges of the second and third segments from the head; but nearer the middle in the segment next to the head. All the abdominal segments covered with fine whitish warts, giving a shagreened appearance to the skin. The lateral raised line very prominent, the body not being thick, but appearing as if partly shrivelled below a dusky lateral stripe. Supra-anal plate large, broad, flat, subtriangular. On the the underside of the body a median dusky linear stripe, on each side of which the body is whitish. Two faint dusky subdorsal lines, one on each side. This is very near to and is congeneric with No. 8 on the fir (p. 237).

10. THE 10-LINED PINE INCH-WORM.

This was also found on the hemlock at Brunswick, August 27.

INSECTS INJURIOUS TO THE 'ROCKY MOUNTAIN SPRUCE (*Abies menziesii*).

AFFECTING THE TRUNK.

1. THE ROCKY MOUNTAIN SPRUCE TIMBER BEETLE.

Dryocates affaber Mannh.

Order COLEOPTERA; family SCOLYTIDÆ.

This beetle occurred (July 7, 1875) in abundance in all stages in a growth of *Abies menziesii*,* the common spruce of the Rocky Mountains,

* This tree was kindly identified for me by Mr. Sereno Watson, from specimens of the leaves and cones sent him for identification.

at Kelso's Cabin, 11,200 feet elevation, on the road to Gray's Peak. It bores into the bark and near the sap-wood in all directions, its burrows resembling those of *Tomicus pini*, with which it is associated, being irregular but much smaller.

The larva is of the usual form of those of the family, being cylindrical and of the same thickness throughout, with the end of the body full and suddenly rounded; segments convex, especially the thoracic ones, and slightly hairy. Head two-thirds as wide as the body, rounded, hone-yellow. Length, 0.15 inch.

The pupa is much like that of *T. pini*, with two anal soft, sharp tubercles. As my specimens are farther advanced than those of *T. pini*, the wings being free from the body, and the abdomen longer, it is impossible for me to draw up a good description. In one example the pupa had retained the larval head, but it was split behind so as not to interfere probably with the development of the adult beetle.

The beetle differs from *Tomicus pini* in its much smaller and slightly slenderer body. The head and prothorax are two-thirds as long as the rest of the body. The abdomen is not scooped out at the end as in *T. pini*, but truncated, moderately rounded, and the end of the abdomen reaches to the end of the wing-covers, which are square at the end instead of excavated as in *T. pini*. Color reddish-brown, much as in *T. pini*. The body is covered with fine, stiff, straight hairs. Length, 0.14. (Packard in Hayden's Report for 1875.)

This insect is said by Leconte to occur in the Lake Superior region, British Columbia, and Alaska.

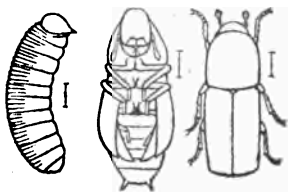


FIG. 93.—a, larva; b, pupa; c, beetle, of the Rocky Mountain spruce timber beetle.—From Packard.

2. THE PINE TIMBER BEETLE.

Tomicus pini Say.

This insect, already described on page 168, is common in the timber region of the Rocky Mountains, boring irregularly into the inner bark of *Abies menziesii*. The burrows are like those made by the same insect in the white pines of New England. The main burrows of the mines observed in Colorado were 0.08 inch in diameter.

3. THE COMMON LARGE RED TIMBER BEETLE.

Dendroctonus rufipennis Kirby.

This beetle, so common in Maine and British America, is also common in the coniferous trees of the mountains of Colorado, where I have met with it at Blackhawk and at Manitou.

4. THE LARGE TIMBER BEETLE.

Dendroctonus terebrans (Olivier).

This common eastern form, which occurs from Maine to Georgia, and in California and Oregon, also probably infests the pine and spruce of elevated regions. I have a specimen from Tacoma, Washington Territory, on Puget Sound, a lumbering place, which was identified by Dr. G. H. Horn.

5. THE WESTERN SPRUCE LONGICORN BORER.

Anthophilax mirificus Bland.

Order COLEOPTERA; family CERAMBYCIDÆ.

This beautiful beetle I found June 16, 1877, under the bark of a large fir-like spruce, probably *Abies menziesii*, on the side of a high hill near Virginia City, Montana. The small male was sexually united with the black female, and there were several other females near by. From these circumstances I have little doubt but that it bores into this tree. There is a great disparity in size and color between the sexes, and the male is much the smaller and is blue-black, with most of the elytra deep brick-red, the ends of the elytra being blue-black, as well as an oblong oval spot at the base of the united elytra; the terminal two-thirds of the abdomen is reddish; it is 16^{mm} long; the female is 21^{mm} long, and entirely blue-black. It was identified by Dr. Horn.

INSECTS INJURIOUS TO THE JUNIPER (*Juniperus virginianus*).

AFFECTING THE TRUNK.

1. THE JUNIPER BARK BORER.

Phloeosinus dentatus (Say).

Order COLEOPTERA; family SCOLYTIDÆ.

Making a short straight primary gallery, with about 15 to 50 longer secondary galleries branching from it at nearly right angles, often ending in round holes perforating the bark; a small white curved grub, changing to a light brown cylindrical beetle.

We have observed the depredations of this common beetle on the junipers about the city of Providence. The attacks were confined to sickly or dead trees; whether the cause of death was due to the attacks of this beetle or not could not be ascertained. The beetles were found May 2 and 13 alive in the burrows, which also contained the fully grown larvæ; but no pupæ were observed. In one fallen juniper tree, the trunk of which was about five inches in diameter, the mines were unusually close together and abundant, 15 occurring on one side of the trunk in a space about one foot long. Selecting a separate average mine for description, such as is figured in the accompanying engraving, the main or primary gallery is 18^{mm} to 25^{mm} (1½ to 2¼ inches) long and 3^{mm} wide, widening at one end into a trilobed chamber twice as wide as the main gallery. In a gallery 25^{mm} long, including the three-lobed cell, from which no lateral or secondary galleries proceeded, there were 48 secondary galleries on one side and 51 on the other, the mouths of the opposing tunnels being alternately arranged. The secondary galleries being a little less than ½^{mm} in width; those arising at each end of the primary gallery are 45^{mm} long; those arising near the middle from one-third to one-half and two-thirds as long; the ends of the tunnels are

about 1.5^{mm} in width, and they often communicate with the hole made by the insect for its exit through the bark, which is 1.5^{mm} or a little less. These holes are indicated by the round black spots or large dots at the end of some of the galleries, as seen in the engraving. The holes may open out straight through the bark as usual, or sometimes obliquely. The galleries in May are closely packed with the excrement or castings of the worms, which is tan colored or the color of the bark, showing that the insects though sinking their galleries a little way into the wood, as proved by the shallow grooves they make in the wood, for the most part burrow through the inner bark, thus loosening it from the wood and causing it to peel off.

The secondary galleries of the same cell rarely cross each other, unless owing to a knot in the trunk or to other irregularities in the wood; but, as seen on the right side of the engraving, one may make a turn and directly cross four or five others, or one from an adjacent mine may cross the galleries of another mine. As a rule, however, the mines of the juniper bark-borer are beautifully regular, and the wood very prettily sculptured.

I have little doubt but that this is the beetle, as it agrees with it in color and size, which I found in considerable numbers under the bark of the cedar or *Thuja occidentalis*, in Northern Maine in 1861. The dead cedars were much infested with these beetles, while they were not noticed in upright, healthy trees.

Leconte states that it inhabits the Middle and Eastern States and Canada, and gives the following description of it:

The beetle.—In the genus *Phloeosinus* the funicle or stalk of the antennæ is much shorter than the club; the first joint is rounded; the remaining four joints are closely united and gradually become broader; the club is large, oval, compressed, obtusely rounded, and divided by straight well-marked sutures. *P. dentatus* is rather smaller than the other species of the genus, except *P. punctatus*, with the declivity of the elytra more abrupt and flattened, and less convex; the striæ are impressed and scarcely punctured, the interspaces are wide, densely and strongly granulate and rugose; the rugosities becoming acute tubercles on the declivity of the alternate interspaces; second interspace not depressed on the declivity and furnished with a row of smaller tubercles in some specimens, but not in others. This difference is probably sexual. The head is granulate-punctate, and the front is not carinate.

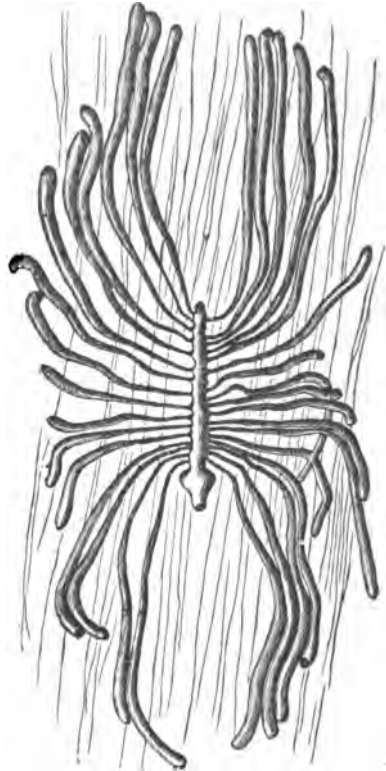


FIG. 94.—Mine of the juniper bark-borer.—
Packard del.

2. THE PRUSSIAN BLUE PINE-BORER.

Callidium antennatum Newman.

In company with the juniper bark-borer, mining dying and dead juniper trees; its mine a long, shallow, irregular sinuous gallery about 6^{mm} wide in the broadest part; the beetles occurring under the bark early in May in Southern New England.

This common borer has already been noticed as infesting the pine (p. 159). It is nearly as common, perhaps, in the juniper; at least I have found it so in the vicinity of Providence, R. I., where it mines dead or dying juniper trees in company with *Phæosinus dentatus*. In one small tree, three inches in diameter, nearly a dozen mines occurred, and as many of the beetles were taken from under the bark on the 2d and again the 13th of May, 1881. It is probable that the beetles had hibernated in their mines, having transformed into the pupa state the previous autumn. The mines may be recognized by their long sinuous shape, beginning very small and gradually widening and ending in a broader space or cell where the larva transforms into the beetle condition; just before the cell, at its widest part, it measures 6^{mm} in width. The larva, as it eats its way along under the bark, does not sink deeply into the wood, simply scoring it, while the gallery is filled behind it with the tan-brown castings of the worm, consisting of partly digested bark, forming a fine paste which hardens and compactly fills the shallow groove. In general appearance the mine of this borer does not essentially differ from that of most of the superficial longicorn borers of other trees. The beetle is entirely deep Prussian blue, and may be readily identified by its color. It varies much in size.

3. THE BLUE-CLOUDED HYLOTRUPES.

Hylotrupes ligneus Fabricius.

We have not personally observed the habits of this borer, which is said by Mr. George Hunt to bore under the bark of *Juniperus virginianus* in Rhode Island. The beetle may easily be recognized by its brown head, antennæ, prothorax, and legs; while the wing-covers are yellowish, with two large adjoining dark Prussian blue patches at the base, the patches rounded behind and extending to the middle of the wing-covers; the terminal third of the wing-covers are also deep Prussian blue, so that only the edges and a transverse copal-yellow band across the wing-covers are left. It is from 9^{mm} to 12^{mm} in length.

AFFECTING THE LEAVES.

4. THE JUNIPER TWIG INCH-WORM.

Diapanodes varus Grote and Robinson.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Very closely resembling the smaller twigs of the juniper, a rough-bodied span or measuring worm an inch and a half long, transforming to an ochre-brown moth.

The adjoining engraving well represents this singular mimetic form, which so closely resembles in form and color the smaller twigs of the juniper. Two of the caterpillars are represented, one holding itself out from the stem by means of its two hinder pairs of feet, while the other clings close to the stem. It is nearly an inch and a half long and less than a line in thickness. Its body is quite rough, with a few prominent tubercles, in size and form resembling the scales left by the falling off of the leaves of the juniper.

The moth may be known by the falcate fore wings, by the three dark spots at the inner angle of the fore wing, and the dark transverse lines; in the females the inner line of the fore wings is much curved and sinuate.

The caterpillar was received from Norwich, Conn., early in June, and on the 17th changed into a beautiful pea-green chrysalis, the moth appearing the 29th of the same month.

The moth.—It has unusually falcate fore wings. The ground color of the upper side of the wings is a pale fawn brown, with a rusty but no purplish tinge, as in some other species of the genus; but the body and antennæ are pale fawn brown. The fore wings at the base are fawn brown, but with rather thick-set black scales, especially towards the inner line. This line is curved zigzag, rusty fawn brown, and is very distinct; it begins at the basal third of the costa, and curving around opposite the discal dot, in a generally oblique direction, ends nearly as far from the base of the wing on the inner edge as on the costa; below the median vein the line is acutely zigzag, forming a tooth just below the lowest median veinlet, followed by a curve inwards on the submedian vein. The discal dot is small, black, but distinct. Just beyond the dot the wing inside of the outer line is rusty, becoming deeper in tone next the line. The outer line is straight, white, narrow, but sharply defined, and forms an acute angle opposite the apex, being reflected back on the costa. The line is shaded externally with dense black scales, becoming thinner towards the outer edge of the wing. From the apex of the bend on the outer line starts a black streak, which is interrupted in the middle, but ends on the lower side of the hooked apex of the wing, which is unusually long and large. The fringe is rust-colored, with the edge white. The outer edge of the wing is deeply hollowed out just below the apex, but below is full and convex. The hind wings are like the fore wings, but without the inner line. The discal dot is distinct, and the outer line is straight, ending just before reaching the costa. There is a broad costal white area. The legs and under side of the wings are fawn-colored, densely speckled with black, giving it a peculiar silky, glossy appearance, suffused with a very slight wine-colored tint. The surface of both wings is uniform; the discal dots are more diffuse than above, being more distinct on the hind wings. The outer line is white, distinct, broader than above, and bent at right angles upon the costa, but the line disappears before reaching the hind edge, which is whitish. The black stripe sent out from the angle of the line, and reappearing on the hinder edge of the apex of the wing, is much as above.



FIG. 85.—Moth, larva, and chrysalis of the juniper twig inch-worm.—From Packard.

On the hind wings the line is straight, broader than on the fore wings, and extends upon the costa. The body is half an inch (.50) in length, and a fore wing measures .65 of an inch in length, expanding 1.30 inches.

5. THE JUNIPER BASKET WORM.

Thyridopteryx ephemeraformis (Haworth).

Order LEPIDOPTERA; family BOMBYCIDÆ.

Feeding sometimes in great numbers on the juniper and the white cedar, a worm living in a large case 1-2 inches long, covered with bits of wings, the female wingless and worm-like; the male dark brown, with small hyaline wings.

This remarkable worm we have found on the juniper tree in Virginia, and according to Harris it sometimes abounds so as to be very destructive to the white cedar (*Cupressus thujoïdes*) in lawns. The following brief account is taken from my "Guide to the Study of Insects." The male of the basket-worm is stout-bodied, with broadly pectinated antennæ and a long abdomen; the anal forceps and the adjoining parts being capable of unusual extension in order to reach the oviduct of the female, which is wingless, cylindrical, and in its general form closely resembles its larva, and does not leave its case. On being hatched from the eggs, which are, so far as known to us, not extruded from its case by the parent, the young larvæ immediately build little elongated basket-like shallow conical cases of bits of twigs of the cedar, and may then be seen walking about, tail in the air, this tail or abdomen covered by the incipient case, and presenting a comical sight. The case of the full-grown larva is elongated, oval cylindrical, and the fleshy larva transforms within it, while it shelters the female through life.

As a remedy hand-picking is an easy and thorough means of getting rid of these creatures if abundant enough to be annoying.

INSECTS INJURIOUS TO THE COMMON JUNIPER (*Juniperus communis*).

1. THE LOW-BUSH JUNIPER INCH-WORM.

Eupithecia miserulata Grote.

Order LEPIDOPTERA; family PHALENIDÆ.

Feeding on the common low spreading juniper bush, a small pea-green span worm, with a narrow thread-like subdorsal, and a wider lateral white line, changing early in June to a chrysalis contained in a thin white cocoon, the small moth appearing at the end of the month and through the summer.

This small delicate common moth was reared by Mr. Cassino at Salem, Mass., and like its European congeners lives on the bush juniper (not on *Taxus baccata*, as stated in my Monograph of geometrid moths). The larva was found late in May, and June 4 began to spin, the pupa being inclosed in a slight white cocoon. It ranges from Maine to Texas.

Larva.—Of the characteristic form, being rather thick in the middle, the body seen dorsally decreasing in thickness from the tail to the head. Supra-anal plate

large, triangular, not acutely pointed, deep red, white on the edges. Head small, not so wide as the prothoracic ring, pea-green, color of the leaves on which it feeds, dorsal line dark-green; subdorsal white, and a wider lateral white line. Segments transversely wrinkled. Body provided with short, black, scattered hairs. Length, 0.50 inch.

Pupa.—Four abdominal segments project beyond the ends of the wings, the thorax and under side of the wings and limbs with a greenish tinge; the rest of the body pale horn-brown, as usual. Head full, convex between the eyes. End of abdomen with a long rounded spine, with three pairs of long hairs curved outwards at the end. Length, 0.28 inch.

Moth.—This is our most common pug-moth, and may be distinguished by the pointed fore wings, with the numerous transverse lines angulated sharply outward, the extradiscal line forming a sharp angle opposite the discal dot, and notched inward on the subcostal vein; by the distinct submarginal wavy white line ending in a large white twin-spot at the inner angle; by the fine dark lines on the hind wings, and by the heavy black costal spots and marginal lines on the under side. The fore wings expand 0.85 inch.

2. THE JUNIPER WEB-WORM.

Dapsilia rutilana Hübner.

Order LEPIDOPTERA; family TORTRICIDÆ.

Ravaging imported junipers, webbing the leaflets, and living within a more or less perfect silken tube, in which the caterpillars hibernate, the twigs and branches presenting a seared and brown appearance.

The following account is taken from Professor Riley's report to the Department of Agriculture for 1878, with the accompanying illustration.

This leaf-roller has been found to seriously injure the imported Irish and Swedish junipers (*Juniperus communis* var.) in nutseries on Long Island, having first become known in this country in 1877; it has not yet been found on our native juniper. It is a well-known English and German moth. There is one annual brood of worms. The insect hibernates at different stages of larval development, and the chrysalis is found throughout the spring months. The moths begin to appear as early as April, but continue to issue during the summer. The worm from birth webs the leaflets together, and lives within a more or less perfect silken tube, this tube being more complete around the hibernating individuals. The sprigs and branches affected by the worm present a seared and brown appearance, and a tree badly affected may be recognized at a great distance.

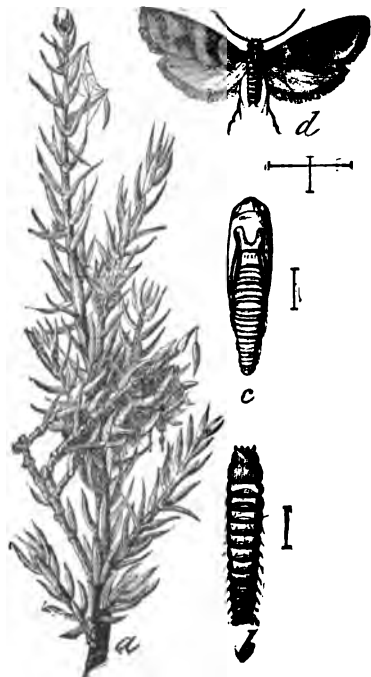


FIG. 96.—The Juniper web-worm: a, sprig of juniper, showing manner in which the larva works; b, larva, dorsal view; c, chrysalis dorsal view; d, moth; b, c, d, enlarged.—After Riley.

The larva.—Of the usual shape, flesh-colored, the head and prothoracic shield highly polished, deep gamboge yellow. Body wrinkled, tapering very gradually from mesothoracic segment to the end of the body; body with small hair-bearing warts, which are extremely small, and indicated more by the short, pale, glistening stiff hairs arising therefrom. Hind borders of abdominal joints slightly thickened dorsally.

Chrysalis.—Color honey-yellow, the skin so delicate that the colors of the moth show clearly through it before emergence. Of the usual shape, long and slender; the abdominal segments having above two transverse rows of rather minute spines; the anus blunt and unarmed; the under side with a few blunt stiff hairs; the antennæ not reaching quite to the tips of the wings. Average length, 5^{mm}.

The moth.—Average expanse of wings, 12^{mm}. Fore wings bright glossy orange, crossed by four reddish-brown bands. The second band from the costa is slightly bent; the third band has the form of a letter K, the top of the K being usually closed, though occasionally open. The apical band is wedge-shaped, reaching nearly to the inferior angle. Frequently this coalesces with the lower part of the third band. Hind wings dark gray, with cilia of the same color. (Riley.)

As a remedy, Riley recommends showering the shrubs with Paris green or London purple, so as to kill the larvæ as they eat the leaves.

3. THE SIX-SPOTTED METACHROMA.

Metachroma 6-notata Say.

Order COLEOPTERA; family CHRYSOMELIDÆ.

Feeding on the leaves in July, an oblong pale shining beetle, 0.15 long, narrower anteriorly and punctured, the punctures in rows on the wing-covers becoming very faint towards their tips, and on each wing-cover three black spots, the forward one long and narrow, the other two situated on the middle, parallel and almost in contact, the inner one placed rather farther back.

4. THE APPLE LEIOPUS.

Leiopus facetus Say.

Order COLEOPTERA; family CERAMBYCIDÆ.

Feeding on the leaves in July, a small black long-horned beetle 0.18 long, with long slender hair-like tawny-yellow antennæ, their basal joint and the tips of two or three following joints black; its thorax with an ash-gray stripe on the middle and an oblique one on each side of this, the hind ends of these stripes sometimes uniting and forming a letter W; its wing-covers with a large ash-gray spot forward of the middle and almost reaching the suture, having in it an oblique triangular black spot, and towards the tip an ash-gray band concave on its hind side.

Mr. Say states that he obtained his specimens from the juniper, but its occurrence thereon was perhaps accidental, as I have found it on apple trees in a section of country where no juniper grows. (Fitch.) We may add that the European *Leiopus nebulosus* Linn., though usually living in the apple and other fruit trees, also in Europe, mines the *Pinus abies* and *P. picea*.

We extract the following account of this and the prickly ash *Leiopus* from our first annual report to the Massachusetts Board of Agriculture:

This new borer in the limbs of the apple was found June 11, in all its stages of growth, in the rotten limb of an apple tree in Chelsea, by Mr.

C. A. Walker. The grubs, or larvæ, were fully grown, and more numerous than the pupæ or adult beetles. How destructive it is, or what the habits of the grubs are, must be ascertained by further observation. It is evident from the facts already known that there is probably but one brood of beetles a year; that they fly about and lay their eggs in the bark of the tree late in June, and probably during July; and that the young larvæ bore in under the bark, and become fully grown in the autumn, spending the winter under the bark probably both in the larva and pupa states, the beetles appearing during midsummer.

The larva is rather long and slender, covered with fine hairs, and the end of the abdomen is rather blunt. The abdominal segments are very convex, and deeply separated by a wide suture. The thorax is about a third wider than the rest of the body. The three thoracic segments together are as long as they are wide. The prothoracic, or segment next the head, is somewhat lunate, and rather longer than the two surrounding segments; on the upper side is a slightly marked somewhat horny square plate, but there is no thickening of the skin on the back of the succeeding segments, as usual in the larvæ of the family (Cerambycidae) to which this borer belongs. It agrees in all respects with the larva of *Leiopus xanthoxyli* Shimer, except that the head is considerably smaller, including the under side and the mouth parts, while the body is not so thick. In all other respects the description of the prickly ash borer (*L. xanthoxyli*) will agree with the present larva, for the larvæ of the two species, which differ very considerably in the beetle state, would be easily confounded. The same remedies may be used against this insect as against the well known striped apple-tree borer (*Saperda candida*).

The beetle itself is a slender, smooth-backed species with no ribs on the wing-covers. It is pale ash-gray, with a slight purplish tinge. The head and prothorax are blackish except on the hinder edge of the prothorax. The antennæ are yellowish brown, with the basal joint and articulations between the other joints dark brown. The wing-covers are pale ash, with a purplish tinge, and an irregular rounded spot just behind the scutellum, united when the wings are folded with a similar spot on the other wing-cover. The shoulder of each wing-cover is tipped with black, which extends backwards from a longitudinal large black spot, extending backwards and connecting with a broad black band which crosses the terminal third of the wing, leaving the tip pale gray. The front edge of this band forms an acute angle in the middle of the wing; this band is sometimes partially wanting, and is then broken up posteriorly into a few black spots. In front of this broad band is an oblique row of short (longitudinal) lines, the first and innermost being shortest; the second one nearly three times as long and parallel to the costal spot. It is a little less than a quarter of an inch (.20) in length.

The prickly ash borer (Leiopus xanthoxyli Shimer, Figs. 97, 99). In this

connection descriptions of the different stages of this species, which has only yet been found in Illinois by Dr. Shimer, to whom I am indebted for specimens, would seem necessary, inasmuch as they throw light on the structure of the apple *Leiopus*. According to Dr. Shimer it bores into the limbs of the prickly ash.

The larva (Fig. 99, *a*, larva; *b*, upper side; *c*, under side of the head) is

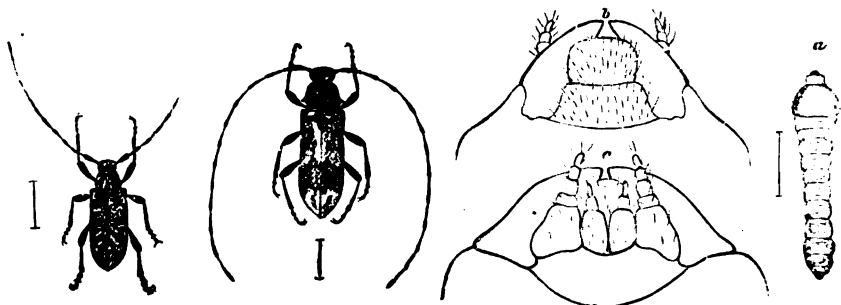


FIG. 97.—*Liopus xanthoxyli*.—From Packard. FIG. 98.—*Liopus facetus*.—From Packard. FIG. 99.—The prickly ash borer.—From Packard.

very much like that of the preceding species. The head is a little more than half as wide as the prothoracic ring. The basal (occipito-epicranial) region is transversely oblong, the basal piece (occiput) being very short, and transversely almost linear, and separated by a well-marked suture from the middle portion (epicranium) of the head, the latter being nearly four times as broad as long, with the front edge straight; it is white, with the front edge pitchy black. The clypeus is smooth, trapezoidal in form, and three times as wide as long. The upper lip (labrum) is thin, hairy, transversely elliptical, a little less than one-half as long as broad. The basal chin piece (submentum) is a large transversely oblong area, with the front edge piceous, and very slightly hollowed, while the posterior edge is very deeply hollowed out. The chin (mentum) is nearly square, widening at the base, which is continuous with the base of the maxillæ, the whole posterior edge being well rounded. The labial palpi are three-jointed, the basal joints of each palpus being large, and no longer than broad, and touching each other; the second joint is much slenderer, and about half as thick as the basal joint; the third joint is not quite so long, and is scarcely half as thick as the second; its tip is acute and reaches out as far as the end of the second joint of the maxillary palpi. The maxillary palpi are four-jointed, very broad at the base; the first joint is scarcely half as long as broad; the third is a little longer than the second, while the fourth is much slenderer than the others, and about the length of the second joint. The mandibles are large and powerful, when closed not reaching as far as the end of the maxillary palpi; the ends are truncated, gouge-like. On the prothorax is a large, obscurely marked, squarish, very slightly horny (chitinous) area, scattered over with hairs, especially on the anterior edge. On the upper side of each segment of the body is a

broad, oval area, with a series of oval gatherings or folds, on each side of the transverse mesial main fold; those on the three rings succeeding the head (thoracic) are the same, but broader. There are no rudimentary thoracic legs. The end of the abdomen is blunt, well rounded, with the extreme tip forming a rounded portion. It is .35 of an inch in length.

The pupa is white, and in the single specimen observed was quite far advanced, the body being covered with hairs. The wings were quite free from the body, and the antennæ curved around outside the wing-covers, their tips meeting at the base of the head. The first and second pairs of legs are folded at right angles to the body, the third pair being oblique to the body. The tips of the first pair of tarsi reach to the base of the second pair of tarsi; the tips of the second pair of tarsi do not reach to the base of the third pair of tarsi, the third tarsi not reaching to the tip of the abdomen by a distance equal to nearly their length. The prothorax is full and convex, the hinder portion being larger in proportion to the rest of the body than in the adult beetle. It is a quarter of an inch in length. The beetle is characterized by four raised lines on each wing-cover, with five or six black dots on each line or rib. An oblique black line diverges from each side of the scutellum. Just in front of the middle is a triangular, pale space, bounded behind by an oblique, dark line. In color it resembles the bark of the ash; it is a quarter of an inch in length.

5. THE JUNIPER SALMON-TINTED CATERPILLAR.

Order LEPIDOPTERA; family NOCTUIDÆ.

Feeding on the leaves of the low-bush juniper, in August, in Maine, a small noctuid caterpillar with five pairs of abdominal legs. Body thickest a little in front of the middle. Head small, rounded, pale honey-yellow, as wide as the prothoracic segment. Body flesh-colored, finely striped with alternating reddish flesh-colored and whitish fine wavy lines; two subdorsal reddish lines broader and less waved than the others, there being about eight reddish lines on each side of the body. The body of this caterpillar is shorter and thicker but shaped somewhat as in *Leucania*. When observed, August 27 to September 12, the caterpillar was about 6^{mm} long.

6. THE JUNIPER WHITE-STRIPED INCH-WORM.

Order LEPIDOPTERA; family PHALÆNIDÆ.

Feeding on the leaves of the low-bush juniper late in summer, in Maine, a rather short, cylindrical inch-worm, pale pea-green, the color of a juniper leaf. Head full, rounded, as wide as the body; segments a little wrinkled transversely. Lateral ridge sharp, white, the white line extending along the side of the obtusely triangular supra-anal plate. No other longitudinal stripes nor any other markings or tubercles.

7. THE JUNIPER TWIG INCH-WORM.

Drepanodes varus G. & R.

This caterpillar, found on the tree-juniper (No. 4), also appears to live on the low-bush juniper, as we beat from a bush the last of August a beautiful green chrysalis which agrees closely with that of *Drepanodes varus*. This chrysalis is of the size and exact form represented in Fig. 95, is smooth bodied, pale pea-green, the exact color of a leaf of its food plant. The body is paler than the wings, with two pale subdorsal yellow stripes; the tip of the abdomen red.

8. THE FIR-NEEDLE INCH-WORM.

This caterpillar was found feeding on the juniper at Brunswick, Me., August 26-29, 1881.

9. THE JUNIPER PLANT-LOUSE.

Lachnus sp.

Common on the juniper in Maine at the ends of the branches.

INSECTS INJURIOUS TO THE LARCH OR TAMARACK (*Larix americana*).

1. The pine bark-beetle (*Tomicus pini*) is reported to mine the bark and outer surface of the sap wood of the tamarack the same that it does the pine.

2. In July and August troops of white caterpillars with black dots and along their backs eight black tufts of hairs, the larvæ of the hickory tussock moth (*Loptocampa caryæ*), are sometimes found on this tree, nearly stripping the leaves from the limbs which they occupy. (Fitch.)

3. In Labrador I have found the larva of *Arctia quenselii* feeding upon the larch in July.

4. THE LARCH CHEATER.

Totype laricis Fitch.

Order LEPIDOPTERA; family BOMBYCIDÆ.

On the limbs in June and July, feeding on the leaves; a large flattened ash gray worm resting appressed to and closely resembling the bark; forming an oblong flattened gray cocoon molded to the limb and resembling the bark in its color; the latter part of July producing a thick-bodied moth with thin delicate wings, which are almost transparent in the males and 1.00 broad, in the females 1.50, and of a white color with faint wavy dusky bands. (Trans. 1855, p. 494. Fitch.)

5. THE IMPERIAL SPINY CATERPILLAR.

Eacles imperialis Hübner.

Noticed on the tamarack by G. D. Hulst (Bulletin Brooklyn Entomological Society, p. 77).

6. THE FIR LOPHYRUS?

A Lophyrus-like false caterpillar which may have been the larva of *Lophyrus abietis*, in 1877 attacked a plantation of Scotch larches. The following letter from Mr. B. M. Watson, proprietor of the Old Colony Nurseries, Plymouth, Mass., written under date of July 5, 1877, will give the facts in the case:

I have a large plantation of Scotch larches, twenty-five years old, forty to fifty feet high, many hundred trees, which is attacked by a caterpillar (enclosed) which I do not find in Harris, or any forestry book which I have at hand. Do you know it or its remedy? The trees are much riddled by them, and the foliage more than two-thirds destroyed. The trees look bare and unsightly. We have had them several years. They began at one end and have advanced to one-fifth of the plantation; the other four-fifths are not infested.

The use of a fluid preparation of Paris green or London purple thrown over the trees by a garden pump or modern machine for such purpose, figured in the Reports and Bulletins of this Commission, would so reduce the numbers of these caterpillars that a second year the trees would leave out again and not show much marks of injury. The Lophyrus sawflies are sporadic and periodical in their attacks; though occasionally doing great and widespread injury.

7. THE LARCH APHIS.

Lachnus laricifex Fitch.

Order HEMIPTERA; family APHIDÆ.

Solitary upon the small twigs, stationed in the axils of the tufts of leaves, with its beak sucking the juices that should go to the leaves, a wingless brown plant-louse slightly tinged with coppery, 0.12 long, with a dull white line along the middle of its back and a similar whitish band at the sutures of each of the abdominal segments, in which bands on each side of the middle are three black punctures, the short tubercles on each side of the tip deep black, the under side dull white and dusted with white powder, the legs pale with the feet and knees black and also the apical half of the hind thighs and shanks, and the antennæ pale with black tips. (Fitch.)

Many of these lice were noticed on a particular tree the latter part of May, but no winged ones were to be found. Ants, as usual, were guarding them and drinking the honey dew which they ejected. Many of them were accompanied with four or more young, huddled close around the base of the sheath from which the leaves arise. These were scarcely half the length of the parent, of a light dull yellow color with two brown spots above on the base of the abdomen, the legs and antennæ similarly colored to those of the parent but more pale. (Fitch.)

8. THE LARCH CHERMES.

Chermes laricifoliae Fitch.

Order HEMIPTERA; family APHIDÆ.

Solitary and stationary upon the leaves, extracting their juices, small black shining flies 0.10 long, having the abdomen dark green, the legs obscure whitish, the wings nearly hyaline with pale brown veins, and the large stigma-spot upon their outer margin beyond the middle more opaque and pale green.

This is closely like the pine Chermes, but has the wings more clear, and differs also in some of the details of its colors. (Fitch.)

INSECTS INJURIOUS TO THE CEDAR OR ARBOR VITÆ—(*Thuja occidentalis*).

1. THE CEDAR TINEID.

Bucculatrix thuiella Packard.

Order LEPIDOPTERA; family TINEIDÆ.

Feeding on the leaves and spinning slender, small, conspicuous white cocoons attached to the leaves, and transforming to a narrow-winged beautiful pearly-white moth, dotted and marked with brown.

The following account is taken from my first report to the Massachusetts board of agriculture:

This is a little moth, of which the caterpillar is unknown, though I found the moths and cocoons in abundance on a cedar tree in Brunswick, Me., July 10. It is undoubtedly similar in its habits to a little moth which lives not uncommonly on the apple tree, and has been described by Dr. Clemens under the name of *Bucculatrix pomifoliella*. Its long, slender, white cocoons may be found, at any time after the leaves have fallen, on the branches of apple trees.



FIG. 100.—The cedar Tineid, enlarged: a, cocoon, nat. size.—From Packard.

Dr. Clemens says that “the larva feeds externally on the leaf of the apple, at least at the time it was taken, in the latter part of September. It is cylindrical and submoniliform; tapers anteriorly and posteriorly; with punctiform points and isolated hairs; first segment with rather abundant dorsal hairs; three pairs of thoracic feet and five abdominal pairs. Head small, ellipsoidal, brown; body dark yellowish green, tinged with reddish anteriorly; hairs blackish and short. Early in October the larva enters the pupa state, wearing an elongated, dirty white, ribbed cocoon, and appears as an imago during the latter part of the following April, or early in May.” The present species seems to be undescribed, and may be called *Bucculatrix thuiella*. It belongs to the extensive Tineid family, and its general appearance is sufficiently indicated by the drawing.

Moth.—The body and wings are pearly white, and the antennæ are white, with brown wings, while there is a low broad tuft of white scales between the antennæ, the crest being much flatter than in the species living on the apple. The fore wings are white, and crossed in the middle by a broad brown band, and beyond this band by alternating white and brown stripes, crossing from the front edge (costa) of the wing. On the end of the wing, and in the middle of the outer edge, is a conspicuous black spot, like the eye in a peacock's feather. To describe the wing and its markings more fully—the basal half of the wing is white, unspotted, except a short, transverse brown band, extending from the inner edge, not quite to the middle of the wing. On each side of this band is a row of two or three minute dots. The middle band is

broadest on the hind edge. Beyond and arising from the costa, where they are broadest, and extending to the opposite side of the wing, are six brown lines, alternating with white interspaces. These lines run together in the middle of the wing, brown dots being added, but which end as distinct lines on the inner edge of the wing. The three outermost lines are much curved, and, with the curve of the fringe, form a circular area, in the middle of which, on the base of the fringe, is the curvilinear, rather thick, dark brown spot. The long fringe on the end of the wing is white at base and brown at the end. The hind wings are pale brown, acutely pointed, with a long silvery fringe. The tibiæ and tarsi of the fore legs are brownish, while the hind legs are white, with a long fringe on the hindermost tibiæ. The length of one fore wing is .18, and the length of the body is .13 inch.

The cocoon is white, tough, dense, slender cylindrical, and .20 inch in length. It is fastened by one side to the leaf, and differs from that of the apple *Bucculatrix* in not being ribbed longitudinally. A minute, beautifully brilliant green ichneumon (*Chalcis*) fly seems to attack in considerable numbers the chrysalids of this insect, as nearly half of those reared by me turned out one of these parasites. It is a species of a genus allied to *Eulophus*, having the antennæ pectinated, the terminal joints throwing off five long branches. It differs, however, from *Eulophus* among other characters by having a short, thick body, a small, conical abdomen, and short, thick antennæ. The fore wings are broad, triangular.

We noticed these beautiful moths again in 1881, at Brunswick, flying about a cedar hedge in considerable numbers from the middle of July until early in August.

2. THE FIR SAW-FLY.

Lophyrus abietis Harris.

False caterpillars closely resembling those found on the fir, and identical with that found on the low-bush juniper, occurred on two cedar hedges in Brunswick, from July 18 to the last of August. But a few scattered individuals occurred. We will give a description of the variety found on the cedar. Body cylindrical, broadest on the thoracic segments; all the segments finely transversely wrinkled. Head small round, deep, amber-colored; eyes black. Body pale green with a broad diffuse dark green medio-dorsal and a lateral stripe. Body paler beneath. Thoracic feet black. Eight pairs of abdominal feet green. Length 13^{mm}. One was found without the three dark stripes. This species differs from the others in the caterpillar having no dark spots on the body as seen in most *Lophyrus* larvæ.

3. THE PROMETHEA MOTH.

Callosamia promethea (Drury).

Said by Mr. Riley to feed on the arbor vitæ. (Fourth Rep., 123.)

INSECTS INJURIOUS TO THE SEQUOIA GIGANTEA.

1. *Gonops fissunguis* Leconte.

"Three specimens from Big Trees, California." (Leconte's *Rhynchophora*.)

2. *A longicorn borer*.

While at the Big Trees of the Mariposa Grove, we observed that one of them had been mined under the bark by what must have been a longicorn borer, as the mine was broad and shallow, being about 4^{mm} broad and about four inches long.

3. THE SEQUOIA ÆGERIAN.

Bembecia sequoiæ Edwards.

Order LEPIDOPTERA; family ÆGERIADÆ.

Very destructive to *Sequoia sempervirens*, as well as to some species of *Pinus*. H. Edwards. (*Papilio*, vol. I, p. 181.)

INSECTS INJURIOUS TO THE CYPRESS (*Taxodium distichum*).

Cecidomyia cupressi-ananassa Riley.

Tennessee. (Riley, *American Entomologist*, ii, 244 and 273. Fig. 153, gall.)

APPENDIX.

AFFECTING THE PERSIMMON:

Psylla dioecyri Ashmead, Can. Ent. 222, Nov. 1881.

AFFECTING THE CATALPA:

Diplosis catalpæ, Comstock's 1880 Rep. Dept. Ag. 266.

AFFECTING THE BAY MAGNOLIA:

Psylla magnoliæ Ashmead, Can. Ent. 224, Nov. 1881.

AFFECTING THE OAK:

Selandria quercus-alba Norton, Trans. Amer. Ent. Soc. i, 258.

Aphis quercifoliæ Walsh, Proc. Ent. Soc. Phil. i, 298, 1863.

Lachnus quercicolens Ashmead, on *Q. virens*, Can. Ent. 154, 1881.

Phyllaphis niger Ashmead, on *Q. phellos* var. *laurifoliæ*, Par. Ent. 155, 1881.

Xyleborus celsus, Leconte's Rhynchophora, 360.

fuscatus, Leconte's Rhynchophora, 360.

Heterocampa subalbicans Grote, Comstock's Rept. for 1880, 259.

Limacodes minuta Reakirt, Proc. Ent. Soc. Phil. iii, 251, 1864.

Cecidomyia quercusmajulis O. Sack. Trans. Amer. Ent. Soc. iii, 53.

Bostrichus bicornis Web. C. E. Worthington, Can. Ent. xii, 107.

AFFECTING THE BUTTERNUT:

Gaurotes cyanipennis, ovipositing on butternut, F. B. Caulfield, Can. Ent. 60, 1881.

Grapholitha caryæ Shimer, Trans. Amer. Ent. Soc. ii, 394.

AFFECTING THE HICKORY:

Catocala febilis, Kellicott in Papilio, 141, 1881.

Chramesus icoriæ, Leconte's Rhynchophora, 375.

Cecidomyia cossæ Shimer, Trans. Amer. Ent. Soc. ii, 395.

caryæ O. Sacken, Monographs, etc. i, 191.

caryæcolor O. Sacken, Monographs, etc. i, 192.

cynipsea O. Sacken, Monographs, etc. i, 193.

glutinosa O. Sacken, Monographs, etc. i, 193.

nototricha O. Sacken, Monographs, etc. i, 193.

persicoides O. Sacken, Monographs, etc. i, 193.

sanguinolenta O. Sacken, Monographs, etc. i, 192.

AFFECTING THE ELM:

Plocetes ulmi, Leconte's Rhynchophora, 213.

FEEDING ON WILD CHERRY:

Cerura borealis, G. H. French in Can. Ent. 145, 1881.

FEEDING ON THE CHESTNUT:

Limacodes viridis Reakirt, Proc. Ent. Soc. Phil. iii, 251, 1864.

Eugonia subsignaria, Comstock's 1880 Rep. Dept. Ag. 271; also on hickory.

FEEDING ON WILLOW:

Cerura occidentalis, G. H. French in Can. Ent. 144, 1881.

Grapholitha galla-saliciana Riley, Trans. St. Louis Acad. Sci. 320, 1881.

AFFECTING THE BASS-WOOD:

Pogonocherus nubilus, according to Leconte.

AFFECTING THE BIRCH:

Apatela spinigera Guen, R. Thaxter, Psyche, ii, 121.

AFFECTING THE MAPLE:

Eunomis alniaria; larva abundant on maple. C. E. Worthington in Can. Ent. x, 16

AFFECTING THE LOCUST:

Eodytlopha insiticiaria Zeller, Comstock's 1880 Rep. Dept. Ag. 260.

Pempelia contatella Grote, Comstock's Rep. Dept. Ag. 261.

AFFECTING THE HONEY LOCUST:

Pempelia gleditschiella Fernald, Comstock's 1880 Rep. Dept. Ag. 262.

AFFECTING THE SCOTCH PINE:

Chermes pinicorticis H. Osborn, Iowa Ag. Report, 96, 1881.

AFFECTING THE PITCH PINE:

Tomiscus exesus, Harris' Treatise, 87.

Tortrix politana, Haworth ?, Comstock's 1880 Rep. Dept. Ag. 264. This is the caterpillar whose case is figured and described on page 207.

AFFECTING PINUS TEDA:

Tetralopha diluculella Grote, Comstock's 1880 Rep. Dept. Ag. 263.

AFFECTING ABIES BRACTEATA:

Grapholitha bracteata Fernald, Comstock's 1880 Rep. Dept. Ag. 265.

AFFECTING THE LARCH:

Tomiscus pini, Harris' Treatise, 88.

Samia columbia (Caulfield).

CORRESPONDENCE.

[The following correspondence relates to certain insects mentioned in the foregoing pages.]

PHILADELPHIA, October 13, 1881.

MY DEAR DOCTOR: I am afraid that some confusion has been produced by the crowded condition of my box of Pityophthori. The specimens have now been properly spaced and arranged, and I have gone over them carefully.

The result is that Blanchard's oak bark species is *P. minutissimus* Zimm., and I consider it as Dr. Harris' *Tom. pusillus*. It agrees very nearly in habits and characters with *P. pubipennis* Lec., from California. The ♂ has the front heavily fringed with long yellow hairs.

The species found by Blanchard (to me No. 36) under white pine bark is *P. sparsus*, and is easily known by the prothorax having a smooth spot each side behind the middle, and by the very shining lustre. The elytra are feebly and sparsely punctured, the declivity is deeply sulcate near the suture, and on the outer limit of the groove are two or three acute cusps. This species is depredated on by *Hypophlaeus tenuis*.

Then there is *P. puberulus*, well described by me from the specimen given me by Ulke. Specimens since received from Schwarz (Port Huron) and Blanchard (Mass., No. 139) have the elytra more strongly punctured.

I am disposed to believe this species from white pine is the one referred to by Dr. Fitch as *Tom. pusillus* Harris. It is about the size of *ramulorum* of Europe, but the elytra are more coarsely punctured, and the punctures are not arranged distinctly in striæ, but are confused. This is probably your 35.

Your No. 34, as I see by reference to Fitch's report, is quoted textually from that author, and if my opinion be well founded, is not different from your 35, unless it be *annectens*. If there are any types to be seen, please have them sought for, and send me one. I have forgotten what became of Fitch's collection.

I am sorry your correspondents have not been more diligent in collecting these destructive insects, so that their characters may be defined, and their habits after-

wards carefully observed. I have made frequent appeals, but have met with no response either inside or outside of the Commission on Forests.

P. annectens Lec., found in Florida in yellow pine, resembles in sculpture *ramulorum*, and agrees with Fitch's description of 34 in having the elytral punctures arranged in rows, and the sutural angle acute. It may really be the same as your 34, but as the localities are so widely apart, and the food tree different, I am unwilling to express a positive opinion until I can compare the specimens. I returned as you requested all that you sent, and I have from you in my collection no other Scolytide than the *Crypturgus* recently received. Perhaps you could get a type of Fitch's *pusillus*. If so it would solve all the difficulties.

Please let your collectors know that in Scolytidæ there is no benefit derived from the study of single specimens. They must be collected in numbers that both sexes may be obtained. As they are always abundant when found there is no difficulty in getting specimens enough.

Very sincerely,

J. L. LECONTE.

NEW YORK, December 12, 1881.

MY DEAR DR. PACKARD: * * *

Sciapteron robinæ Hy. Edw. is extremely destructive in California and Nevada to the white poplar (*Populus alba*) and to the downy poplar (*Populus canescens*), both of these species being introduced into the Pacific States as ornamental trees. A small avenue of the latter at San Leandro, near San Francisco, was utterly destroyed by the *Sciapteron*, the pupa cases being found sticking out of the holes in hundreds. The perfect insect was rather scarce, as they emerge very early in the morning, and take flight with the first gleam of sunshine. *Sciap. robinæ* also destroys the locust trees (*Robinia pseudoacacia*), a grove of this species in Napa County being observed by me in a state bordering upon destruction from the attacks of this insect.

Sciapteron syringæ (*Trochilium syringæ* Harris) has been found to be a pest to ash trees in Brooklyn, N. Y. Some observations upon this and other species of *Egeridæ* will shortly be published by Rev. G. D. Hulst.

Bembecia sequoia Hy. Edw. is devastating the pine forests of Mendocino County, California, and is particularly destructive to *Sequoia sempervirens*, *Pinus ponderosa*, and *Pinus Lambertiana*. The eggs appear to be laid in the axils of the branches, the young caterpillar boring in a tortuous manner about its retreat, thus diverting the flow of the sap, and causing large resinous nodules to form at the place of its workings. These gradually harden, the branch beyond them dies, and the tree at last succumbs to its insignificant enemies. Hundreds of fine trees in the forests of the region indicated are to be seen in various stages of decay. A similar habit seems to prevail in the life history of *Sciapteron pini* Kellicott, a species described by its author in the Can. Entom., 1881.

Bembecia marginata (*Troch. marginatum* Harris) attacks the bushes of various species of *Rubus*. Mr. Hulst has made admirable observations upon this species, and will, I hope, soon give them to the world.

Yours, truly,

HENRY EDWARDS.

CAMBRIDGE, November 14, 1881.

DEAR PROFESSOR PACKARD: Your letter of the 9th instant was duly received. Before replying I have waited to get from Dr. Hagen a list of species of insects taken by me last September on the highest peak of Ktaadn. They were put in spirits and handed to Dr. H. without examination on my part. As he has just given me the list of all that can interest you in your present inquiries, I will send it with a few words of my own.

In my trips to Ktaadn in 1879, 1880, and 1881, I did not see about the mountain, nor on the way to and from it, any increase of dead spruces above what I observed in my visits of 1869 and 1871. There are now, as in the earlier years, the usual proportion and no more of dead and bleached spruce trunks standing among the living, but none recently dead and retaining their bark.

I camped in the Basin seven days in 1879, thirteen days in 1880, sixteen days in 1881. The only borers I ever saw there—to know them—are *Prionus unicolor* and *Monohammus scutellatus*. In 1879 I saw more of the former, but this year none of that, while the latter swarmed everywhere—but ten days later in the month. These two species I have known for years. Thinking that you might possibly find in a list of my unexamined species the new destroyer, I asked Dr. Hagen to prepare one. But though I have forgotten the name of this recent pest, you will not find it among the species collected by me. This fact and the other, that no unusual killing of spruces appears to have taken place lately in the Ktaadn region, indicate of course that the destroyer has not penetrated thither.

I took insects only on the highest peak, hoping to get by chance something not found lower down, though aware that the season for characteristic Alpine species had long passed. But you will probably find in the list only species common at lower elevations. Their presence on the summits I suppose you will attribute, in part at least, to their being blown there by winds. My collection of wild black spiders may, on examination, prove different from low-ground species. Please note that this abundance of *M. scutellatus* occurs high above the growth of *Pines*, which are not found at all in the Basin.

Yours, truly,

C. E. HAMLIN.

Insects taken on highest peak of Mt. Ktaadn, September, 1881.

6 *Monohammus scutellatus* Say.

1 *Leptura canadensis*.

1 *Buprestis maculiventris*.

1 *Melanotus communis*.

1 *Clerus dubius*.

Upis sp. ?

2 *Scymnus* sp. ? (very small).

Atta pennsylvanica.

INDEX.

	Page.		Page.
Abbot's white-pine saw-fly.....	195	Anarsia pruniella	135
Abia cerasi	134	Anchylopera platanana	139
Abies alba, insects injurious to....	219	Angular-headed marbled fir inch-	
balsamea, insects injurious to	235	worm	237
canadensis, insects injurious		Anisopteryx vernata	61, 138
to	240	Anisota pellucida	45
menziesii, insects injurious to	242	rubicunda	109
nigra, insects injurious to...	219	senatoria	45
Acanthoderes, 4-gibbus	55, 75, 131	stigma	45
morrisii	131	Anornata pinicola	216
Acer rubrum, insects injurious to..	103	Anthaxia viridicornis	68
saccharinum, insects injurious		viridifrons	75
to	103	Anthophilax mirificus	244
Acorn moth	53	Antiopa butterfly	64
worm	52	Apate basillaris	74
Acrobasis juglandis	82, 85	bivittatus	230
Acronycta	140	Apatela americana	111, 127
acericola	140	brumosa	139
americana	142	radcliffei	136
hastulifera	127, 132	Apatelodes angelica	138
occidentalis	126	torrefacta	142
populi	116	Aphis aceris	115
salicis	142	cerasifoliæ	135
ulmi	69	cratægifolii	138
Actias luna	76, 85, 89, 131, 138, 142	diospyri	138
Adelges abieticolens	234	Aphrophora parallella	189
abietis	235	saratogensis	189, 215
Ædilis nodosus	159	Apion rostrum	101
obsoletus	159	Aplodes mimosaria	49
Ægeria acerni	106	Apple Leiopus	250
denudatum	138	Arbor vitæ, insects injurious to...	256
pini	180	Argyresthia austerella	69
tibiale	123	Argyrolepis quercifoliata	54
tricincta	121	Arhopalus fulminans	24, 55, 90
Æoia ostræella	139	Asemum næstum	157
Ægnippe biscolorella	133	Asinina triloba	132
Agrilus	75	Aspidiotus juglandis	86
eugenus	75	Aspidisca diospyriella	138
American Cimbex saw-fly	64	juglandiella	85
Clostera	122	saliciella	143
silk-worm	48, 90, 113	splendoriforella	134, 136
timber-beetle	29	ostræfoliella	139
Amphalocera cariosa	132	Athysanus abietis	129, 235
Amphidasys cognataria	114	fenestratus	128
Amyot's Otiocerus	82	minor	128

	Page.		Page.
<i>Athysanus variabilis</i>	128	<i>Buprestis chlorocephala</i>	20
<i>Attelabus analis</i>	85	<i>lineata</i>	149
<i>bipustulatus</i>	51	<i>rusticorum</i>	149
<i>rhois</i>	139, 140	<i>striata</i>	148
Autumnal locust leaf-miner	99	<i>ultramarina</i>	149
<i>Bactra ? argutana</i>	69	<i>fasciata</i>	144
<i>Balaninus caryatrypes</i>	93	Butternut, insects affecting the	
<i>nasicus</i>	83, 139	leaves	86
<i>rectus</i>	52	insects affecting the	
Banded tree-hopper	81	trunk and limbs	85
<i>Batrachedra præangusta</i>	143	insects injurious to	85
<i>salicipomonella</i>	143	leaf-miner	90
<i>artiolata</i>	143	Tingis	88, 129
Beautiful hickory-borer	69	tree-hopper	88
Beech, insects injurious to	129	woolly worm	86
leaf-miner	130	<i>Byrsocrypta ulmicola</i>	68
span-worm	129	<i>Bythoscopus</i>	144
<i>Bellamira scalaris</i>	129	<i>strobi</i>	216
Belted Chion	70	<i>Calaptris betulella</i>	129
<i>Betula lenta</i> , insects injurious to ..	128	<i>Californian lappet moth</i>	43
Birch aphid	129	<i>Phryganidea</i>	43
insects affecting the leaves ..	128	tent-caterpillar	41
insects injurious to	128	<i>Callaspidia quercus-globulus</i>	39
<i>Biston ursaria</i>	121	<i>Callidium antennatum</i>	159, 246
Black-birch borer	129	<i>Calligrapha scalaris</i>	140
horned <i>Callidium</i>	159	<i>Callipterus betulæ ?</i>	129
locust midge	101	<i>betulæcolens</i>	129
margined gay-louse	80	? <i>caryellus</i>	79
walnut, insects affecting the		<i>castaneæ</i>	93
leaves	84	<i>fumipennellus</i>	80
walnut, insects affecting the		<i>maculellus</i>	80
trunk	84	<i>marginellus</i>	80
walnut, insects injurious to ..	84	? <i>punctatellus</i>	79
walnut sphinx	84, 90	<i>ulmicola</i>	68
<i>Blastobasis coccivorella</i>	54	<i>Callosamia promethea</i>	131, 134, 138, 257
Blue-clouded <i>Hylotrupes</i>	246	<i>Camaranotus confusus</i>	217
Boring <i>Hylurgus</i>	175	<i>Canadian Leptura</i>	240
<i>Bostrichus bicornis</i>	55	Canker worm	61
<i>cavifrons</i>	230	<i>Capsus</i>	144
<i>Brachys ærosa</i>	52	<i>clavatus</i>	219
<i>æruginea</i>	130	<i>Carpoborus bicristatus</i>	179
<i>Brepheos infans</i>	129	<i>bifurcus</i>	179
<i>Bronchelia hortaria</i>	131	<i>Carya alba</i>	69
Brown chestnut beetle	90	<i>tomentosa</i>	69
<i>Prionus</i>	30	<i>Castanea vesca</i>	90
beetle	241	<i>Catastega aceriella</i>	114
<i>Bruchus</i>	134	<i>timidella</i>	56
<i>prosopis</i>	133	<i>Catocala concumbens</i>	142
<i>uniformis</i>	133	<i>fratercula</i>	48
<i>Bucculatrix thuiella</i>	256	<i>parta</i>	146
<i>trifasciella</i>	94	<i>ultronia</i>	134
Buckeye stem-borer	132	<i>Cecidomyia aceris</i>	115
Buprestid borer	241	<i>albiovittata</i>	144

	Page.		Page.
<i>Cecidomyia crataegi-bedeguar</i>	136	Chestnut insects affecting the fruit	93
<i>citrina</i>	127	insects affecting the leaves	92
<i>cornuta</i>	144	insects affecting the trunk	
<i>cupressi ananassa</i>	258	and limbs	90
<i>gleditschiæ</i>	134	insects injurious to	90
<i>liriodendri</i>	131	Phylloxera	93
<i>orbitalis</i>	144	tree borer	90
<i>pellex</i>	138	tree-hopper	92
<i>pseudacacia</i>	101	weevil	93
<i>pudibunda</i>	140	<i>Chion cinctus</i>	70
<i>robinia</i>	102	<i>Chrysobothris dentipes</i>	12, 147
<i>S. batatas</i>	143	<i>femorata</i> ... 16, 107, 133, 136	
<i>S. brassicoides</i>	143	<i>harrisii</i>	147
<i>S. coryloides</i>	143	<i>octocola</i>	133
<i>S. cornu</i>	143	<i>6-signata</i>	128
<i>S. gnaphalioides</i>	143	<i>trinervia</i>	147
<i>S. hordeoides</i>	143	<i>Chrysomela bigsbyana</i>	144
<i>S. nodulus</i>	143	<i>philadelphica</i>	215
<i>S. rhodoides</i>	143	<i>scalaris</i>	64, 126
<i>S. siliqua</i>	143	<i>spireæ</i>	144
<i>S. strobiloides</i>	143	<i>Cicada septemdecim</i>	35
<i>S. strobiliscus</i>	143	seventeen year	5
<i>S. triticoides</i>	143	<i>Cimex americana</i>	64, 69
<i>S. verruca</i>	143	<i>laportei</i>	69
<i>serotina</i>	135	<i>Cirrho platanella</i>	139
<i>serrulata</i>	140	<i>Citheronia regalis</i>	76
<i>tiliæ verrucicola</i>	127	<i>sepulcralis</i>	203
<i>tulipiferæ</i>	131	<i>Cixius cintifrons</i>	81
<i>Cecropia caterpillar</i>	113	<i>colapenum</i>	81
moth	89	<i>pini</i>	217
Cedar, insects injurious to	256	<i>Clastoptera obtusa</i>	88
tineid	256	<i>pini</i>	216
<i>Cemiotoma albella</i>	143	<i>testacea</i>	216
<i>Centronopus anthracinus</i>	55	<i>Cleora pulchraria</i>	205
<i>calcaratus</i>	55	<i>Clinton's tussock moth</i>	53
<i>Ceratomia amyntor</i>	127	<i>Clisiocampa americana</i>	134
<i>quadricornis</i>	67	<i>californica</i>	41
<i>Ceresa brevicornis</i>	81	<i>constricta</i>	41
<i>Cerura borealis</i>	134, 142	<i>disstria</i>	40
<i>multiscripta</i>	142	<i>erosa</i>	103
<i>occidentalis</i>	142	<i>sylvatica</i>	40, 112, 138
<i>Chaitophorus negundinis</i>	133	Cloudy-tipped <i>Cixius</i>	81
<i>populicola</i>	117	Club-horned <i>Capsus</i>	219
<i>salicicola</i>	144	<i>Clytus colonus</i>	27
<i>Chalcophora angulicollis</i>	146	<i>nobilis</i>	91
<i>liberta</i>	146	Coal-black <i>Hylastes</i>	177
<i>virginiensis</i>	145	<i>Coccus pinicorticis</i>	185
<i>Chariessa pilosa</i>	75	<i>Cœlodasya unicornis</i>	135, 136
Checkered pine sphinx caterpillar ..	202	<i>Coleophora ostryæ</i>	140
spine measuring worm ..	232	<i>pruniella</i>	134
<i>Chermes laricifolia</i>	255	<i>querciella</i>	54
<i>pinifolia</i>	218	<i>tiliæ-foliella</i>	127
Chestnut caterpillar	94	<i>Comma butterfly</i>	66
gay-louse	93	Commixed <i>Leptostylus</i>	157

	Page.		Page.
Common elm aphid	68	<i>Cynips corrugera</i>	57
elm tree borer	58	coxii	57
hickory borer	69, 70	floccosa	57
large red timber-beetle ..	243	formosa	56
longicorn pine-borer	152	gemula	57
oak Clytus	27	globulus	56
Cone-headed spruce caterpillar ..	233	ignota	57
<i>Conotrachelus elegans</i>	83	ilicifoliae	56
crategi	138	inanis	56
nenuphar	135	irregularis	56
<i>Coriscium</i>	54	majalis	56
albanotella	55	minuta	57
<i>Coscinoptera dominicana</i>	55, 138	modesta	57
<i>Cosmia orina</i>	47	nigra	57
<i>Cossus centerensis</i>	119	noxiosa	57
oak	11	omeratus	39
<i>Cotalpa lanigera</i>	144	operator	57
Cottonwood dagger-moth	116	ostensackenii	56
insects affecting the		palustris	57
leaves	115	papula	57
insects affecting the		pattoni	57
trunk and branches ..	115	phellos	56
insects injurious to ..	115	pigra	57
<i>Criocephalus agrestis</i>	158	podagræ	57
nubilis	162	polita	57
<i>Cresus latitarsus</i>	129, 134	punctata	57
<i>Cryptolechia faginella</i>	131	quercus-arbos	38
quercicella	55	quercus-batatus	39
<i>Crypturgus atomus</i>	180, 231, 236, 241	quercus-coccineæ	56
<i>Cupes concolor</i>	232	quercus-ficus	39
<i>Cyllene antennatus</i>	133	quercus-tuber	38
crinicornis	138	rugosa	57
picta	70, 75, 84, 90, 95	scitula	57
<i>Cymatophora paupinaria</i>	142	sculpta	56
<i>Cynips</i>	56	seminator	39
aciculata	56	similis	57
affinis	57	singularis	56
(<i>Andricus</i>) flocci	56	spongifica	56
(<i>Andricus</i>) fusiformis	56	strobilana	56
(<i>Andricus</i>) futilis	56	suttonii	57
(<i>Andricus</i>) papillata	56	tenuicornis	57
(<i>Andricus</i>)	56	(<i>Teras</i>) forticornis	56
(<i>Andricus</i>) seminator	56	(<i>Teras</i>) fulvicollis	56
batatoides	57	(<i>Teras</i>) hirta	56
batatus	56	(<i>Teras</i>) nigricollis	56
bella	57	(<i>Teras</i>) pezomachoides	56
(<i>Biorhiza</i>) nigra	56	tubicola	56
capsula	57	tumisica	57
centricola	56	ventricosa	57
cicatricula	57	verrucarum	56
cinerosa	57	vesicula	57
clavula	56	<i>Cypress</i> , insects injurious to	258
cælebs	56	<i>Dakruma pallida</i>	54
confluens	56	<i>Dapsilia rutilana</i>	249
corrugis	57		

	Page.		Page.
Darapsa chœrilus.....	138	Elm gall-louse.....	68
Dark elm-bark borer.....	59	insects affecting the leaves...	61
Daremma undulosa.....	138	insects affecting the trunk....	58
Dendroctonus brevicornis.....	177	insects injurious to.....	58
frontalis.....	177	measuring worm.....	122, 123
punctatus.....	177	saw-fly.....	69
rufipennis.....	176, 243	span-worm.....	62
similis.....	177	Enchenopa binotata.....	88
simplex.....	177	Endropia bilinearia.....	49
terebrans.....	243	pectinaria.....	50
Depressaria robiniiella.....	98	Ephippophora caryana.....	83
Diapheromera femorata.....	77	Epirrita dilutata.....	63
Diedrocephala quadrivittata.....	80	Ergates spiculatus.....	162
Dicercia divaricata.....	108, 131, 135	querci.....	38
lurida.....	72	ulmi.....	68
prolongata.....	151	Ernobius tenuicornis.....	180
punctulata.....	150	Eriosoma caryæ.....	75
tenebrosa.....	151	Eros coccinatus.....	115
tuberculata.....	151	Euchronia maia.....	53, 142
Dichelonycha albicollis.....	216	Euclea monitor.....	53
elongatula.....	140, 144	querceti.....	53
Diplosis annulipes.....	144	quercicola.....	53
atricornis.....	144	Eudamus tityrus.....	100
atrocularis.....	144	Euderes pini.....	159
decem-maculata.....	144	Eugonia alniaria.....	91, 127
pini-rigide.....	213	subsignaria.....	62, 123, 127
resinicola.....	211	Enpithecia miserulata.....	248
septem-maculata.....	144	Enpogonius pinivora.....	156
Diraphia vernalis.....	217	vestitus.....	75
Discoidal Saperda.....	70	Eupsalis minuta.....	20
Dominican case-bearer.....	55	European spruce bud louse.....	235
Dorcaschema nigrum.....	73	Entrapela transversata.....	112
Dorytomus mucidus.....	115	Euura orbitalis.....	140
Dotted-winged gay-louse.....	79	S. gemma.....	140
Drepanodes varus.....	254	S. nodus.....	140
Drepanosiphum tilie.....	127	S. ovulum.....	140
Dryobius sex-fasciata.....	59, 131	S. ovum.....	140
Dryocætes affaber.....	242	Evacanthus orbitalis.....	144
septentrionis.....	175	Evippe prunifoliella.....	135
Drummond's buprestid.....	150	Exartema inornatana.....	54
Dularius brevilineus.....	60		
Dysphaga tenuipes.....	72	Face-banded Cixius.....	81
		Fagus ferruginea.....	129
Eacles imperialis.....	138, 139, 140, 1422, 202	Fall web-worm.....	67, 189
	34, 254	Feeble oak-borer.....	30
Ecyrus dasycerus.....	75	Fine writing bark-beetle.....	166
Elaphidion atomarium.....	55	Fir harlequin caterpillar.....	234, 239
mucronatum.....		Lophyrus.....	255
parallelum.....	55	needle inch-worm.....	237, 254
villosum.....	30	saw-fly.....	197, 257
Ellema coniferarum.....	201	scale insect.....	240
harrisii.....	201	tree, insects affecting the leaves	236
pinenm.....	202	tree, insects affecting the trunk	235
Elm bark borer.....	59	tree, insects injurious to.....	235
galeruca.....	64	tree saw-fly.....	236

	Page.		Page.
Fitch's oak-leaf miner.....	52	Green pine Tettigonia.....	217
Flat-headed apple-tree borer	107	stinging Io caterpillar	110
Forest tent caterpillar	40, 112	striped maple-worm	109
Four-horned sphinx caterpillar....	67		
striped leaf-hopper	80	Hadrobregmus foveatus.....	241
Fourteen-flapped fir inch-worm	238	Halesidota caryæ.....	53, 76, 89
Freckled leaf-hopper.....	80	maculata	46, 138
		tesselaris	53, 139
Galeruca californiensis	64	Hamadryas bassettella	55
Galerucella sagittaria	144	Harlequin oak-geometer.....	49
Gastropacha americana	114, 129	Harris's Buprestis.....	147
californica	43	pine hawk-moth	202
Gaurotes cyanipennis.....	138	Prionus	162
Gelechia sp. ?	143	Helice pallidochrella.....	133
coryliella	139	Hemispherical butternut scale insect	86
fungivorella.....	143	Hemlock bark borer	241
gallægenitella	55	inch-worm	242
pinifoliella	208, 240	insects affecting the leaves	241
querciella	55	insects injurious to	240
quercinigræella.....	55	Heterachthes quadrimaculatus	75
quercifoliella	55	Heterocampa pulvereæ	46, 53
quercivorella.....	55	Heterogenea shurtleffii.....	133
pseudacaciella.....	99, 103	Heterophelps triguttata	114
robinæfoliella.....	99	Hibernia tiliaria	125
salicifungella	143	Hickory aphid	76
Glycobius speciosus	103	bark borer	73
Glyptoscelis hirtus	215	bark louse	75
Goes debilis	30	blight	75
pulcher.....	69	gay-louse	79
pulverulentus	131	insects affecting the fruit.	83
tigrinus	69	insects affecting the leaves	76
Golden Buprestis.....	148	insects injuring the trunk	
Gonops-fissunguis	258	and branches.....	69
Gracilaria alnicolella	140	insects injurious to.....	69
alnivorella	140	leaf witherer	78
blandella	85	nut weevil	83
juglandinigræella	85	round-gall	78
negundella	133	shuck-worm	83
ostryæella	140	slug caterpillar.....	83
packardella	114	spiny gall.....	79
purpurilla	143	stem gall-louse.....	78
salicifoliella.....	142	tussock moth	53, 76, 89, 103
sassafrasella	138	twig girdler.....	71
Grape Phymatodes.....	25	vein gall-louse.....	78
Graphisurus fasciatus	22, 108	Hilipus squamosus.....	180
Grapholitha gallæsaliciana.....	142	Hispa quadrata	127
Grapta americana	127	Holocera glandulella	53
comma	66	Homoptera salicis	142
interrogationis	65, 127	Hoplia trifasciata	144
progne	66	Hoplosia nubila	131
Gray-sided oak-weevil	22	Horn-tail borer	28, 69, 105
Great elm-leaf beetle	64	Hyalæ coryliella	139
Greater locust-leaf Gelechia.....	99	Hydria undulata	142
Green and red oak span-moth.....	51	Hylastes carbonarius.....	177
headed Buprestis.....	20	porculus	177

	Page.		Page.
<i>Hylecetus americanus</i>	29	<i>Ladder Chrysomela</i>	64
<i>Hylesinus aculeatus</i>	138	<i>Lemosaccus plagiatu</i>	75
<i>opaculus</i>	59, 138	<i>Large green tree-bug</i>	82
<i>Hylobius pales</i>	178	<i>longicorn borer</i>	241
<i>Hylotrupes bajulus</i>	160	<i>maple span-worm</i>	112
<i>ligneus</i>	246	<i>pine flat-headed borer</i>	145
<i>Hylurgops pinifex</i>	177, 232	<i>scallop-winged geometer-</i>	
<i>Hylurgus terebrans</i>	175	<i>moth</i>	49
<i>Hyperchiria io</i>	53, 103, 110, 123, 134, 135,	<i>spiny caterpillar</i>	202
138, 142		<i>timber-beetle</i>	243
<i>Hyperetis nyssaria</i>	129	<i>Larix americana</i> , insects injurious	
<i>Hyperplatys aspersus</i>	115	<i>to</i>	254
<i>Hyphantria textor</i>	67, 89	<i>Lateral saperda-borer</i>	59
<i>Hypomolyx pinicola</i>	180	<i>Laverna ? gleditschiæella</i>	133
		<i>leaf-miner beetle</i>	127
<i>Ianthaphe platanella</i>	139	<i>rolling weevil</i>	51
<i>Ichthyura albosigma</i>	121	<i>Least spruce bark-borer</i>	231, 241
<i>Americana</i>	122	<i>white-pine bark-borer</i>	172
<i>vau</i>	122	<i>Lecanium</i>	240
<i>Imperial spiny caterpillar</i>	254	<i>acericola</i>	115
<i>Incurvaria acerifoliella</i>	114	<i>acericorticis</i>	115
<i>Interrogation butterfly</i>	65	<i>caryæ</i>	75
<i>Io moth</i>	53, 103	<i>juglandifex</i>	86
		<i>quercifex</i>	38
<i>Jassus inoratus</i>	80	<i>quercitrionis</i>	38
<i>Juglans cinerea</i>	85	<i>tulipifera</i>	131
<i>nigra</i>	84	<i>Le Conte's saw-fly</i>	197
<i>Juniper bark-borer</i>	244	<i>Leiopus facetus</i>	250
<i>basket-worm</i>	248	<i>querci</i>	24
<i>common, insects injurious</i>		<i>Leptostylus commixtus</i>	157
<i>to</i>	248	<i>macula</i>	85
<i>insects affecting the leaves</i>	246	<i>Leptura zebra</i>	55
<i>insects affecting the trunk</i>	244	<i>Lesser locust-leaf Gelechia</i>	99
<i>insects injurious to</i>	244	<i>maple span-worm</i>	112
<i>plant-louse</i>	254	<i>pine-borer</i>	157
<i>salmon-tinted caterpillar</i>	253	<i>Prionus</i>	160
<i>twig inch-worm</i>	246, 254	<i>Liberated Buprestis</i>	146
<i>web-worm</i>	249	<i>Limacodes scapha</i>	77
<i>white striped inch-worm</i>	253	<i>Lime inch-worm</i>	125
<i>Juniperus communis</i> , insects injuri-		<i>Limenitis disippus</i>	123
<i>ous to</i>	248	<i>misippus</i>	142
<i>virginianus</i> , insects inju-		<i>Linden borer</i>	124
<i>rious to</i>	244	<i>dipterous gall-fly</i>	127
		<i>insects affecting the leaves</i>	125
<i>Lachnus</i>	254	<i>insects affecting the trunk</i>	124
<i>abietis</i>	235	<i>insects injurious to</i>	124
<i>alnifoliae</i>	140	<i>leaf-beetle</i>	125
<i>caryæ</i>	76	<i>Liopus cinereus</i>	75
<i>laricifex</i>	255	<i>xanthoxyli</i>	132
<i>longistigma</i>	127	<i>Liriodendron tulipifera</i>	131
<i>strobi</i>	188	<i>Lithacodes fasciola</i>	112
<i>Larch aphid</i>	255	<i>Lithocolletis</i>	94
<i>cheater</i>	254	<i>aceriella</i>	114
<i>Chermes</i>	255	<i>ariferella</i>	54
<i>insects injurious to</i>	254	<i>albanotella</i>	55

	Page.		Page.
<i>Lithocolletis alnifoliella</i>	140	<i>Lophyrus abietis</i>	197, 234, 236, 257
<i>alnivorella</i>	140	<i>lecontei</i>	197
<i>argentifimbriella</i>	53	<i>pini-rigidæ</i>	199
<i>argentinotella</i>	69	Low-bush juniper inch-worm	248
<i>auronitens</i>	140	Luna moth	85, 89
<i>basistrigella</i>	54	silk-moth	76
<i>bethuneella</i>	54	Lurid <i>Dicerca</i>	72
<i>bicolorella</i>	54	<i>Lyctus striatus</i>	75
<i>bifasciella</i>	54	Lyda saw-fly	200
<i>caryæfoliella</i>	85, 90	<i>Lymexylon sericeum</i>	29
<i>castanæella</i>	54, 94	<i>Lyonetia alniella</i>	140
<i>cinnamatiella</i>	54		
<i>clemensella</i>	114	<i>Machimia tentoriferella</i>	55, 135
<i>coryliella</i>	139, 140	<i>Magdalis olyra</i>	28
<i>cratægella</i>	134, 135, 136	<i>Maguolia</i>	132
<i>fitchella</i>	52, 54	<i>umbrella</i>	132
<i>fuscocostella</i>	55	Maia moth	53
<i>guttifinitella</i>	133	<i>Mallodon dasystomus</i>	28
<i>hageni</i>	55	<i>melanopus</i>	28
<i>hamadryadella</i>	51, 54	Maple dagger-moth	111
<i>intermedia</i>	55	insects affecting the leaves..	109
<i>lucetiella</i>	127	insects injurious to	103
<i>lucidicostella</i>	114	leaf-cutter	114
<i>mirifica</i>	55	moth	129
<i>obscuricostella</i>	139	semi-looper	113
<i>obstrictella</i>	55	slug-moth	112
<i>ostryæfoliella</i>	139	Marbled pine-borer	156
<i>quercialbella</i>	54	<i>Marmara salictella</i>	143
<i>quercipulchella</i>	54	<i>Melanophila drummondi</i>	150
<i>quercitorum</i>	54	<i>fulvoguttata</i>	150
<i>robiniella</i>	99	<i>Melanophila longipes</i>	228
<i>salicifoliella</i>	146	<i>Metachroma 6-notata</i>	250
<i>tiliæella</i>	127	<i>Metanema quercivoraria</i>	51, 69
<i>tritæniæella</i>	139	<i>Metrocampa perlaria</i>	142
<i>tuliferella</i>	54	<i>Micracis hirtella</i>	138
<i>ulmella in elm</i>	54, 69	<i>suturalis</i>	132
<i>unifasciella</i>	54	<i>Molorchus bimaculatus</i>	75
Little bark-beetle	170	<i>Monocesta coryli</i>	64
Livid greenspruce measuring-worm	233	<i>Monohammus confusor</i>	152, 227, 235
<i>Lonchæa</i>	144	<i>marmoratus</i>	156
Locust borer	95	<i>scutellatus</i>	156
carpenter-moth	6	<i>Mordella 8-punctata</i>	55
<i>Depressaria</i>	98	Muscle-shaped butternut bark-	
goat-moth	103	louse	86
<i>Hispa</i>	100	<i>Mytilaspis conchiformis</i>	135
insects affecting the leaves	98	<i>pinifolia</i>	218
insects affecting the trunk	95	<i>pomicorticis</i>	136, 138
insects injurious to	95		
leaf-miner	98	<i>Nadata gibbosa</i>	114
or hickory borer	90	<i>Nematocampa filamentaria</i>	53, 114
saw-fly	102	<i>Nematus</i>	140
skipper butterfly	100	<i>fur</i>	140
Longicorn borer	258	<i>hospes</i>	140
Long-legged <i>Melanophila</i>	238	<i>inquilinus</i>	140
<i>Lophyrus abbotii</i>	195	<i>mendicus</i>	140

	Page.		Page.
<i>Nematus similaris</i>	102	Oak-tumor gall-fly	38
<i>S. desmodioides</i>	140	tussock caterpillar	46
<i>S. pisum</i>	140	tussock moth	53
<i>S. pomum</i>	140	<i>Oberea mandarina</i>	115
<i>Neoclytus capere</i>	138	<i>schaumii</i>	115
<i>erythrocephalus</i>	60, 73, 75	<i>Obtuse Clastoptera</i>	88
<i>Nephopteryx (Pinipestis) zimmer-</i>		<i>Odontota scutellaris</i>	100
<i>manni</i>	182	<i>Oecanthus nivens</i>	60
<i>fulmi-arrosorella</i>	69	<i>Oeta compta</i>	132
<i>undulatella</i>	69	<i>Oncideres angulatus</i>	71, 75
<i>Nepticula</i>	143	<i>Ophioderma mera</i>	88
<i>amelauchierella</i>	136	<i>Ophiusa bistrians</i>	113
<i>anguinella</i>	54	Orange-striped oak-worm	45
<i>castaneæfoliella</i>	94	<i>Oregon Ruprestis</i>	146
<i>clemensella</i>	139	<i>Orgyia antiqua</i>	136
<i>corylifoliella</i>	139	<i>leucographa</i>	138
<i>eratægifoliella</i>	136	<i>leucostigma</i>	69, 89, 103, 132, 239
<i>juglandifoliella</i>	85	<i>Ornix cratægifoliella</i>	136
<i>fuscotibiæella</i>	143	<i>innsitatumella</i>	136
<i>maximella</i>	139	<i>prunivorella</i>	134
<i>ostryæfoliella</i>	140	<i>quadripunctella</i>	135
<i>platea</i>	54, 139	<i>quercifoliella</i>	55
? <i>prunifoliella</i>	134	<i>Orthosoma brunneum</i>	30, 160, 241
<i>querciostanella</i>	54	<i>Osmoderma scabra</i>	131
<i>quercipulchella</i>	54	<i>Otiocerus amyotii</i>	82
<i>saginella</i>	54		
<i>scrotiæella</i>	134	<i>Pachybrachys livens</i>	144
<i>virginiella</i>	140	<i>Pachylobius picivorus</i>	184
<i>Noble chestnut-borer</i>	91	<i>Pacific oak tent-caterpillar</i>	41
<i>Noctuid larva</i>	238	<i>Pales weevil</i>	178
<i>Northern brenthian</i>	20	<i>Pandelestius hilaris</i>	22
<i>Notched-winged geometer-moth</i> ..	91	<i>Papaw, insects injurious to</i>	132
<i>Notodonta dictæa</i>	123, 142	<i>Papilio crespfontes</i>	132
<i>November moth</i>	63	<i>troilus</i>	138
		<i>turnus</i>	127, 134, 136
<i>Oak-bark weevil</i>	28	<i>Parallel spittle-insect</i>	189
blight	38	<i>Parandra brunnea</i>	127, 131
bullet gall-flies	39	<i>Paraphia subatomaria</i>	205
fig gall-fly	39	<i>unipunctataria</i>	48, 69
<i>Heterocampa</i>	46	<i>Parectopa robinella</i>	98
insects affecting limbs and		<i>Parorgyia clintonii</i>	53
twigs	30	<i>parallela</i>	204
insects injuring the leaves	40	<i>Peach and cherry flat-headed borer</i> ..	108
insects injuring the seed		<i>Pemphigus fraxinifolii</i>	138
(acorns)	52	<i>popularia</i>	122
insects injurious to	5	<i>populeanlis</i>	117, 122
leaf <i>Phylloxera</i>	52	<i>populi globuli</i>	123
leaf tortrix	54	<i>populi monilis</i>	117
<i>Leiopus</i>	24	<i>ramulorum</i>	117
potato gall-fly	39	<i>transversus</i>	117
pruner	30	<i>pseudobyrsa</i>	117
slug-worm	53	<i>renæ</i>	123
span-worm	48	<i>vagabundus</i>	117
tree gall-fly	38	<i>Pheosia rimosa</i>	142

	Page.		Page.
Philadelphia Chrysomela.....	115	Pine Parorgyia	204
Phlaeosinus dentatus	244	Thecla	201
Phobetrum pitheciun	47	timber-beetle	173, 232, 243
Phryganidea californica.....	43	tube-builder	207
Phyllobanus dislocatus	75	twig tortrix	193
Phyllocnistis liquidambarisella.....	138	Pinipestis zimmermanni	232
liriodendrella	131	Pinus rigida	145
magnoliæella.....	132	strobis	145
Phyllodecta vulgatissima.....	144	Pissodes strobis	185, 228, 236, 241
Phylloxera caryæ-globuli	78	Pitch drop moth	182
caryæ-semen	78	eating weevil.....	184
caryæ-venæ	78	inhabiting midge	211
caryæ-caulis.....	78	pine needle gall-fly.....	213
fallax	79	pine Retinia	194
caryæ-foliæ	78	pine saw-fly	199
caryæ-gummosa	79	pine twig tortrix	189
caryæ-ren	79	Pitted Buprestis	150
caryæ-septa	79	Pityophthorus materarius	173, 232
castaneæ	93	puberulus	172
conica	79	Plagioderia scripta	115
depressa	79	Platycerura fureilla	203
forcata	79	Platysamia cecropia	113
rileyi	52	Plectrodera scalator	144
spinosa	79	Pogonocherus mixtus	140
Phymatodes variabilis	25	Polyphemus silk-worm	47
varius	27	Poplar Ageria	121
Phyton pallidum.....	75	borer	115, 117
Pig hickory slug-worm.....	83	bullet gall-louse	123
Pig-nut leaf weevil	83	gall-louse	122
Pine ægerian	180	goat-moth.....	119
Anomala	216	insects affecting the leaves ..	121
bark beetle.....	168	insects affecting the trunk..	117
bark carver.....	175	insects injurious to	117
blight	185	stem gall-louse.....	122
Chrysomela.....	215	vein gall-louse	123
Cixius	217	Populus monilifera	115
Clastophora	216	tremuloides	117
Dicerca	151	Porter Hylotrupes	160
eating gay-beard.....	156	Prickly ash	132
Enderces	159	black caterpillar	123
Hylastes	177	caterpillar	123
insects affecting the leaves ..	195	Prionus brevicornis	127
insects affecting the trunk ..	145	emarginatus	161
insects affecting the twigs....	185	laticollis.....	118
insects injurious to.....	145	Pristiphora sycophanta	140
leaf Chermes	218	Promethea moth	257
leaf miner	208, 240	Protesteras æsculana	132
leaf scale-insect	218	Prussian blue pine-borer	240
longicorn borer	227, 235	Psalocorsis quercicella.....	54
louse mimicker	217	Psylla annulata	114
measuring worm	205	carpini	140
mite	240	Ptilinus basalis	133
needle span-worm.....	206	Pulvinaria innumerabilis.....	135
Nemat'us	215		
Nephopteryx	232	Quercitron bark borer.....	22, 108

	Page.		Page.
Quercitron scale insect	38	Sequoia gigantea, insects injurious to	258
Quercus, insects injurious to	5	Seventeen-year locust	35
Red and yellow striped pine span- worm	206	Short-horned tree-hopper	81
and yellow striped spruce meas- uring-worm	233	lined Dularius	60
headed green inch-worm	238	thick longicorn borer	241
shouldered Apate	74	Silky timber-beetle	29
striped pine measuring-worm ..	205	Silvanus bidentatus	92
tailed Attelabus	85	Silver-c-Grapta	66
Regal walnut caterpillar	76	Six-spotted Metachroma	250
Retinia comstockiana	189	Sinoxylon basillare	74, 75
frustrana	193	Siphonophora acerifolia	114
rigidana	194	cratægi	138
Rhagium lineatum	162, 229, 236	lirioidendri	131
Rhaphigaster pennsylvanicus	82	Six-banded Dryobius	59
Rhynchites æratus	144	flapped slug-worm	47
Rhyncolus angularis	144	Sixteen-legged maple borer	106
Ribbed Rhagium	162, 229	Skiff caterpillar	77
Robinia pseudacacia	95	Slender Dicerca	151
Rocky Mountain spruce timber bee- tle	242	footed Dysphaga	72
Rosey-striped oak-worm	45	Smaller leaf-hopper	128
Samia cecropia	89	Smerinthus excæcatus	134, 142
cynthia	131, 132, 134, 138, 142	geminatus	138, 142
Saperda bivittata	135, 136, 138	juglandis	84, 90, 139
calcarata	115, 117	modesta	117
concolor	118	myops	134
discoidea	70, 75	Smilia castaneæ	92
lateralis	59, 140	inornata	93
mæsta	118	Smodicum cucujiforme	28, 131
(Mecas) inornata	140	Smoky-winged gay-louse	80
tridentata	58	Snout moth caterpillar	207
vestita	123, 124	Southern pine hawk-moth	201
Saratoga leaf-hopper	215	Southern Tomicus	168
spittle-insect	189	Speckled spiny oak-worm	45
Saw-fly	129	Spermophagus robinia	103
Say's weevil	101	Sphinx chersis	138
Schizoneura fagi	131	gordius	138
imbricator	131	kalmia	138
pinicola	217	hylaüs	132
tessellata	140	Spilosoma virginica	88, 136, 205
ulmi	68	Spined spruce bark borer	230
Sciapteron robinia	103, 127	Spotted Leptostylus	85
Scoliapteryx libatrix	142	winged Buprestis	149
Scolytus fagi	131	winged gay-louse	80
4-spinosus	73	Spruce bud louse	234
Seed-gall hickory Phylloxera	78	insects affecting the leaves ..	232
Selandria	83	insects affecting the trunk ..	242
carya	86	insects injurious to	219
tilia	127	insects injurious to the trunk	227
Semicolon butterfly	127	leaf-hopper	123
Sericoris inscrutana	132	least bark-borer	180
		Rocky Mountain, insects injurious to	242
		saw-fly	234

	Page.		Page.
Spruce timber-beetle.....	175	Tomicus.....	170
tree leaf hopper.....	235	cacographus.....	168
tree plant-louse.....	235	calligraphus.....	166
twig mimicker.....	233	(Phloiotribus) liminaris ..	59
Stegania pustularia.....	112	pini.....	168, 243
Stenoscelis brevis.....	109	Tooth-legged buprestid.....	147
Stenosphenus notatus.....	73	Chrysobothris.....	12
Stenotrachelys approximaria.....	49	Tortrix cerasivorana.....	134
Stout pine-borer.....	176	larva.....	133
poplar span-worm.....	121	rileyana.....	82, 85
Streaked cotton-wood beetle.....	115	Tragidion fulvipenne.....	55
Sugar-maple borer.....	103	Tragosoma harrisii.....	162
Swallow-tail.....	127	Tree cricket.....	60
Synchroa punctata.....	55, 68	Tremex columba.....	28, 69, 105, 129
Syneta tripla.....	128	Tribolium.....	75
		Triple-rowed Syneta.....	123
Tamarack, insects injurious to	254	Tuberculated Buprestis.....	151
Taxodium distichum, insects injuri-		Tulip tree.....	131
ous to.....	258	Tussock moth.....	239
Telamona fasciata.....	81	Two-crested southern timber-beetle	179
unicolor.....	81	forked southern timber-beetle	179
Telea polyphemus.....	47, 90, 113	lined oak geometer-moth....	49
Telephorus cordinus.....	129	marked tree-hopper.....	88
fraxini.....	129	toothed Silvanus.....	92
Ten-lined pine inch-worm.....	237, 241	Tylonotus bimaculatus.....	129, 138
lined pine span-worm.....	206		
Testaceous Clastophora.....	216	Ultramarine Buprestis.....	148
Thecla.....	83	Unadorned tree-hopper.....	93
falacer.....	136	Unarmed spruce bark-borer.....	229
niphon.....	201	Unknown buprestid larva.....	228
Thelia univittata.....	37	measuring-worm.....	62
Therina endropiaria.....	53	Urocera abdominalis.....	185
Thick-thighed Chrysobothris.....	16	albicornis.....	184
Three-toothed oak geometer-moth.....	50	Uroplata rosea.....	135, 136
Thuja occidentalis.....	256	Uroxiphus caryæ.....	80
Thunderbolt beetle.....	24		
Thyridopteryx ephemeræformis ..	248	Vanessa antiopa.....	64, 123, 142
Thysanocnemis fraxini.....	138	Vaporer moth.....	49
Thysanoës fimbriicornis.....	75	caterpillar.....	69
Tillomorpha geminata.....	75	Variable leaf-hopper.....	128
Tingis hyalina.....	44	Vernal Diraphia.....	217
juglandis.....	88, 129	Virginia tiger-moth.....	88
Tischeria badiella.....	54	V-marked Clostera.....	122
castaneæella.....	54, 94		
citrinipennella.....	54	Walking-stick.....	77
complanoides.....	54	Walnut case-bearer.....	82, 85
concolor.....	54	leaf-roller.....	82, 85
malifoliella.....	136	sword-tail.....	80
pruinoseella.....	54	Western spruce longicorn borer....	244
quercitella.....	54	White-banded Phymatodes.....	27
quercivorella.....	54	blotch oak-leaf miner.....	51
tinctoriella.....	54	horned Urocera.....	184
zelleriella.....	54	lined caterpillar.....	239
Tolyte laricis.....	254	lined tree-hopper.....	37
velleda.....	69	necked pine-beetle.....	216

	Page.		Page.
White oak Phymatodes	25	Xyleutes borer	119
oak scale-insect	38	(Cossus) querciperda	11
pine Aphis	188	populi	119
pine leaf-hopper	216	robinæ	6, 163, 123, 142
pine Schizoneura	217	Xyloterus bivittatus	175, 229, 236
pine tufted caterpillar	203	politus	108
pine weevil	185, 228, 236, 241	Xylotrechus colonus	114
Clostera	121	convergens	138
scutelled pine-borer	156		
Windowed leaf-hopper	128	Yellow-banded Urocenus	185
Wood-engraver bark-beetle	163	bear	205
Wool-sower gall-fly	39	dotted Buprestis	150
Woolly elm-tree louse	68	elm louse	68
		locust midge	102
		tree-hopper	81
Xestobium affine	109		
Xiphidria attenuata	12	Ypsolophus querciella	55
Xyloborus cælatus	175, 230, 236	quercipomonella	55
celsus	75		
impressus	173	Zanthoxylum americanum, insects	
xylographus	163	injurious to	132
Xylesthis clemensella	103	Zerene catenaria	139
pruniramiella	135		

6807

May 21. 1877.

DEPARTMENT OF THE INTERIOR.
U. S. GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.
F. V. HAYDEN, IN CHARGE.

BULLETIN

OF

THE UNITED STATES

ENTOMOLOGICAL COMMISSION.

DESTRUCTION OF THE YOUNG OR UNFLEDGED LOCUSTS.

No. 1.

SECOND EDITION.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
June, 1877.

DEPARTMENT OF THE INTERIOR.
U. S. GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.
F. V. HAYDEN, U. S. GEOLOGIST-IN-CHARGE.

BULLETIN
OF
THE UNITED STATES
ENTOMOLOGICAL COMMISSION.

ON THE NATURAL HISTORY OF THE ROCKY MOUNTAIN LOCUST,
AND ON THE HABITS OF THE YOUNG OR UNFLEDGED INSECTS
AS THEY OCCUR IN THE MORE FERTILE COUNTRY IN
WHICH THEY WILL HATCH THE PRESENT YEAR.

No. 2.

SECOND EDITION.

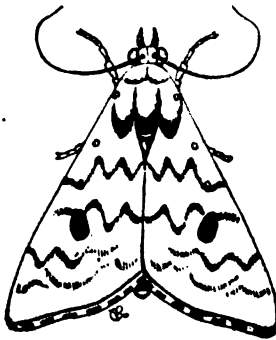
WASHINGTON:
GOVERNMENT PRINTING OFFICE.
June, 1877.

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 3.

THE COTTON WORM.

SUMMARY OF ITS NATURAL HISTORY, WITH AN ACCOUNT OF
ITS ENEMIES, AND THE BEST MEANS OF CONTROLLING
IT; BEING A REPORT OF PROGRESS OF THE
WORK OF THE COMMISSION.



By CHAS. V. RILEY, M. A., Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

JANUARY 28, 1880.

ORDER TO PRINT.

CONGRESS OF THE UNITED STATES,

IN THE HOUSE OF REPRESENTATIVES, *March 19, 1880.*

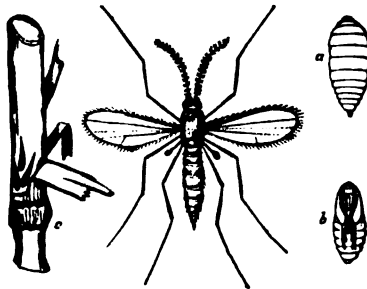
Resolved by the Senate (the House of Representatives concurring), That there be printed 10,000 additional copies of Bulletin No. 3 of the United States Entomological Commission on the Cotton-Worm: 6,000 copies for the use of the House, 3,000 for the use of the Senate, and 1,000 for the use of the Department of the Interior.

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 4.

THE HESSIAN FLY,

ITS RAVAGES, HABITS, ENEMIES, AND MEANS OF
PREVENTING ITS INCREASE.



By A. S. PACKARD, Jr., M. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
MAY 20, 1880.

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 5.

THE CHINCH-BUG.

ITS HISTORY, CHARACTERS, AND HABITS, AND THE MEANS OF
DESTROYING IT OR COUNTERACTING ITS INJURIES.



I

By CYRUS THOMAS, Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1879.

IN THE SENATE OF THE UNITED STATES,

March 19, 1880.

Resolved, That there be printed, with necessary illustrations, at the Government Printing Office, three thousand extra copies of Bulletin No. 5 of the United States Entomological Commission, on the subject of the chinch-bug; two thousand copies for the use of the Senate and one thousand copies for the use of the Department of the Interior.

Attest:

JNO. C. BURCH, *Secretary*.

6804 Oct. 14. 1881

DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 6.

GENERAL INDEX

AND

SUPPLEMENT

TO THE

NINE REPORTS

ON THE

INSECTS OF MISSOURI.

BY

CHARLES V. RILEY, M. A., Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

MARCH 24, 1881.

6807. Apr. 5. 1882.

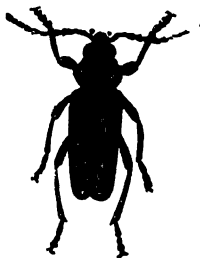
DEPARTMENT OF THE INTERIOR.
UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 7.

INSECTS

INJURIOUS TO

FOREST AND SHADE TREES.



By A. S. PACKARD, Jr., M. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1881.



3 2044 106 181 241

